Request by Lamont-Doherty Earth Observatory for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals during a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras, September–October 2014

submitted by

Lamont-Doherty Earth Observatory
61 Route 9W, P.O. Box 1000
Palisades, NY 10964-8000

to

National Marine Fisheries Service
Office of Protected Resources
1315 East–West Hwy, Silver Spring, MD 20910-3282

Application Prepared by

LGL Limited, environmental research associates
22 Fisher St., POB 280
King City, Ont. L7B 1A6

18 February 2014

LGL Report TA8350-2

TABLE OF CONTENTS

Request by Lamont-Doherty Earth Observatory for an Incidental Harassment Authorization to Allow the Incidental Take of Marine Mammals during a Marine Geophysical Survey by the R/V *Marcus G. Langseth* in the Atlantic Ocean off Cape Hatteras, September–October 2014

SUMMARY

Lamont-Doherty Earth Observatory (L-DEO), with funding from the U.S. National Science Foundation (NSF), proposes to conduct a high-energy, 2-D seismic survey on the R/V *Marcus G. Langseth* in the northwest Atlantic Ocean ~17–422 km from the coast of Cape Hatteras in September–October 2014. The proposed seismic survey would use a towed array of 36 airguns with a total discharge volume of ~6600 in^3 or 18 airguns with a total discharge volume of ~3300 in^3. The seismic survey would take place outside of U.S. state waters, mostly within the U.S. Exclusive Economic Zone (EEZ) and partly in International Waters, in water depths 20–5300 m. This request is submitted pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371(a)(5).

Numerous species of marine mammals inhabit the northwest Atlantic Ocean. Several of these species are listed as ***endangered*** under the U.S. Endangered Species Act (ESA): the sperm, North Atlantic right, humpback, sei, fin, and blue whales. Other ESA-listed species that could occur in the area are the ***endangered*** leatherback, hawksbill, green, and Kemp's ridley turtles, roseate tern, and Bermuda petrel, and the ***threatened*** loggerhead turtle and piping plover. The ***endangered*** Atlantic sturgeon and shortnose sturgeon could also occur in or near the study area. ESA-listed ***candidate species*** that could occur in the area are the Nassau grouper, dusky shark, and great hammerhead shark.

The items required to be addressed pursuant to 50 C.F.R. § 216.104, "Submission of Requests", are set forth below. They include descriptions of the specific operations to be conducted, the marine mammals occurring in the study area, proposed measures to mitigate against any potential injurious effects on marine mammals, and a plan to monitor any behavioral effects of the operations on those marine mammals.

I. OPERATIONS TO BE CONDUCTED

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

Overview of the Activity

The proposed survey area is located between ~32–37°N and ~71.5–77°W in the Atlantic Ocean ~17–422 km off the coast of Cape Hatteras (Fig. 1). Water depths in the survey area are 20–5300 m. The seismic survey would be conducted outside of state waters and mostly within the U.S. EEZ, and partly in International Waters, and is scheduled to occur for ~38 days during 15 September–22 October 2014.

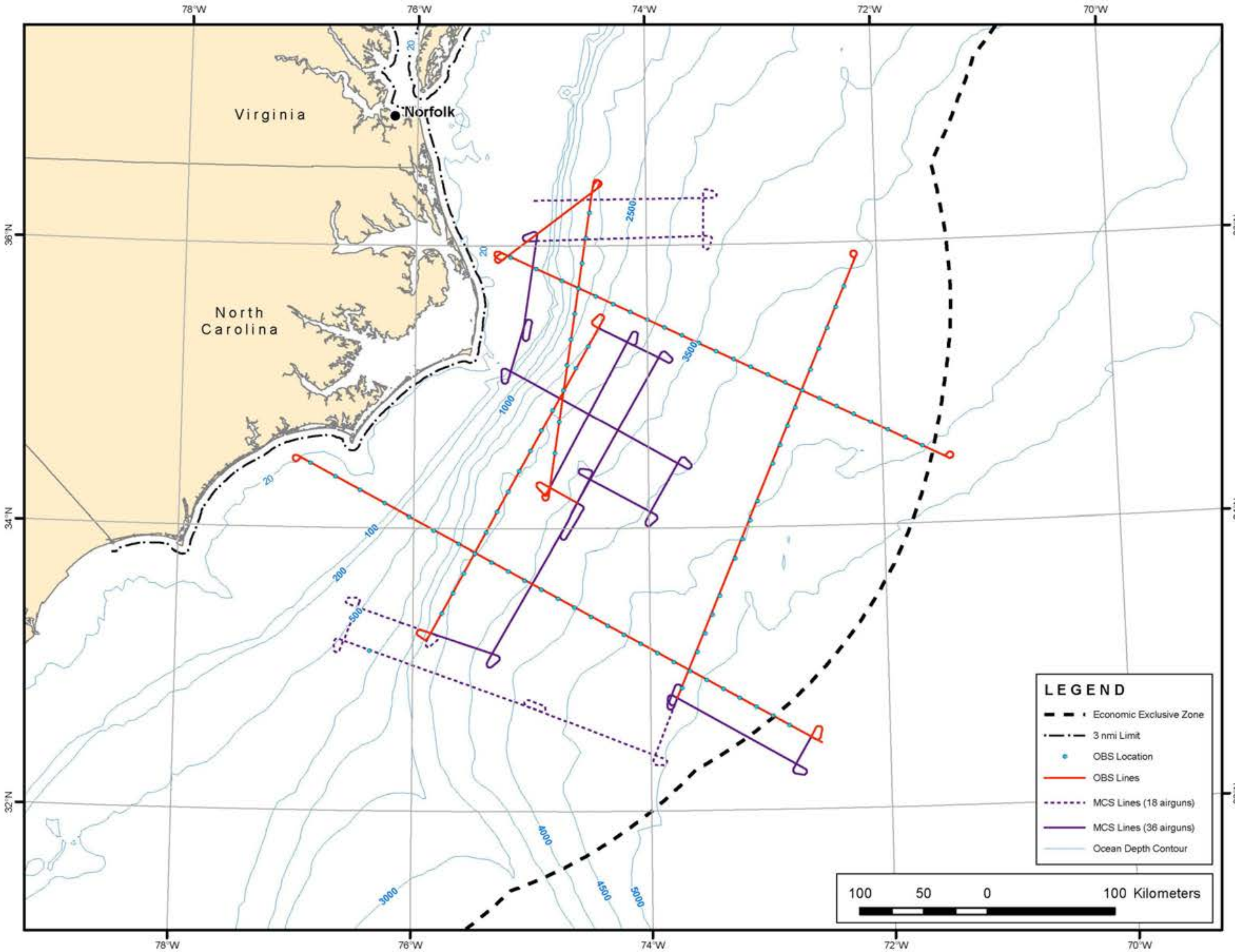


FIGURE 1. Location of the proposed seismic survey in the Atlantic Ocean off Cape Hatteras during September–October 2014.

The procedures to be used for the survey would be similar to those used during previous seismic surveys by L-DEO and would use conventional seismic methodology. As noted previously, the goal of the proposed research is to collect and analyze data along the mid-Atlantic coast of the East North America Margin (ENAM). The study area covers a portion of the rifted margin of the eastern U.S., from unextended continental lithosphere onshore to mature oceanic lithosphere offshore. The data set would therefore allow scientists to investigate how the continental crust stretched and separated during the opening of the Atlantic Ocean, and what the role of magmatism was during continental breakup. The study also covers several features representing the post-rift modification of the margin by slope instability and fluid flow.

To achieve the project's goals, the Principal Investigators (PIs), Drs. H. Van Avendonk and G. Christeson (University of Texas at Austin), B. Magnani (University of Memphis), D. Shillington, A. Bécel, and J. Gaherty (L-DEO), M. Hornbach (Southern Methodist University), B. Dugan (Rice University), M. Long (Yale University), M. Benoit (The College of New Jersey), and S. Harder (University of Texas at El Paso), propose to use a 2-D marine seismic reflection and refraction survey to map sequences off Cape Hatteras. Objectives that would be met from conducting the proposed research include gaining insight in slope stability and the occurrence of past landslides. Slope stability is important for estimating the risk of future landslides. Landslides can result in tsunamis; such as the tsunami that occurred offshore eastern Canada in the early 20th century, and resulted in the loss of lives. The risk for landslides off the eastern U.S. is not known.

The survey would involve one source vessel, the *Langseth*, which is owned by NSF and operated on its behalf by Columbia University's L-DEO, supported by a chase vessel. The *Langseth* would deploy an array of 36 airguns as an energy source with a total volume of ~6600 in^3 or an array of 18 airguns with a total discharge volume of ~3300 in^3. The receiving system would consist of an 8-km hydrophone streamer or 90 ocean bottom seismometers (OBSs). The OBSs would be deployed and retrieved by a second vessel, the R/V *Endeavor*. As the airgun array is towed along the survey lines, the hydrophone streamer would receive the returning acoustic signals and transfer the data to the on-board processing system. The OBSs record the returning acoustic signals internally for later analysis.

A total of ~5000 km of 2-D survey lines, including turns (~3650 km MCS and ~1350 km OBS lines) are oriented perpendicular to and parallel to shore (Fig. 1). The OBS lines would be shot a second time with the streamer, for a total of ~6350 km. There would be additional seismic operations in the survey area associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard. In our calculations (see § VII), 25% has been added for those additional operations.

In addition to the operations of the airgun array, a multibeam echosounder (MBES), a sub-bottom profiler (SBP), and an acoustic Doppler current profiler (ADCP) would also be operated from the *Langseth* continuously throughout the survey. All planned geophysical data acquisition activities would be conducted by L-DEO with on-board assistance by the scientists who have proposed the study. The vessel would be self-contained, and the crew would live aboard the vessel with some personnel transfer on/off the *Langseth* by the chase vessel.

Source Vessel Specifications

The R/V *Marcus G. Langseth* is described in § 2.2.2.1 of the Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey (NSF and USGS

2011) and Record of Decision (NSF 2012), referred to herein as the PEIS. The vessel speed during seismic operations would be 4.5 kt (~8.3 km/h).

The R/V *Endeavor* has a length of 56.4 m, a beam of 10.1 m, and a maximum draft of 5.6 m. The *Endeavor* has been operated by the University of Rhode Island's Graduate School of Oceanography for over thirty years to conduct oceanographic research throughout U.S. and world marine waters. The ship is powered by one GM/EMD diesel engine, producing 3050 hp, which drives the single propeller directly at a maximum of 900 revolutions per minute (rpm). The vessel also has a 320-hp bowthruster. The *Endeavor* can cruise at 18.5 km/h and has a range of 14,816 km.

Other details of the *Endeavor* include the following:

Owner:	National Science Foundation
Operator:	University of Rhode Island
Flag:	United States of America
Date Built:	1976 (Refit in 1993)
Gross Tonnage:	298
Accommodation Capacity:	30 including ~17 scientists

The chase vessel would be a multi-purpose offshore utility vessel similar to the *Northstar Commander*, which is 28 m long with a beam of 8 m and a draft of 2.6 m. It is powered by a twin-screw Volvo D125-E, with 450 hp for each screw.

Airgun Description

During the survey, two energy source configurations would be used: the *Langseth* full array consisting of four strings with 36 airguns (plus 4 spares) and a total volume of ~6600 in^3, or a two-string array consisting of 18 airguns and a total volume of 3300 in^3. The airgun arrays are described in § 2.2.3.1 of the PEIS, and the airgun configurations are illustrated in Figures 2-11 to 2-13 of the PEIS. The 4-string array would be towed at a depth of 9 m for the OBS and MCS lines of the survey, and the 2-string array would be towed at a depth of 6 m. Shot intervals would be 65 s (~150 m) during OBS seismic, and ~22 s (50 m) during MCS seismic.

Predicted Sound Levels

During the planning phase, mitigation zones for the proposed marine seismic survey were calculated based on modeling by L-DEO for both the exclusion and the safety zones. Received sound levels have been predicted by L-DEO's model (Diebold et al. 2010, provided as Appendix H in the PEIS), as a function of distance from the airguns, for the 36-airgun array at any tow depth and for a single 1900LL 40-in^3 airgun, which would be used during power downs. This modeling approach uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). In addition, propagation measurements of pulses from the 36-airgun array at a tow depth of 6 m have been reported in deep water (~1600 m), intermediate water depth on the slope (~600–1100 m) and shallow water (~50 m) in the Gulf of Mexico (GoM) in 2007–2008 (Tolstoy et al. 2009; Diebold et al. 2010).

For deep and intermediate-water cases, the field measurements cannot be used readily to derive mitigation radii, as at those sites the calibration hydrophone was located at a roughly constant depth of 350–500 meters, which may not intersect all the sound pressure level (SPL) isopleths at their widest point from the sea surface down to the maximum relevant water depth for marine mammals of ~2000 m. Figures 2 and 3 in Appendix H of the PEIS show how the values along the maximum SPL line that connects the points where the isopleths attain their maximum width (providing the maximum distance associated with each sound level) may differ from values obtained along a constant depth line. At short ranges, where the direct arrivals dominate and the effects of seafloor interactions are minimal, the data recorded at the deep and slope sites are suitable for comparison with modeled levels at the depth of the calibration hydrophone. At larger ranges, the comparison with the mitigation model—constructed from the maximum SPL through the entire water column at varying distances from the airgun array—is the most relevant. The results are summarized below.

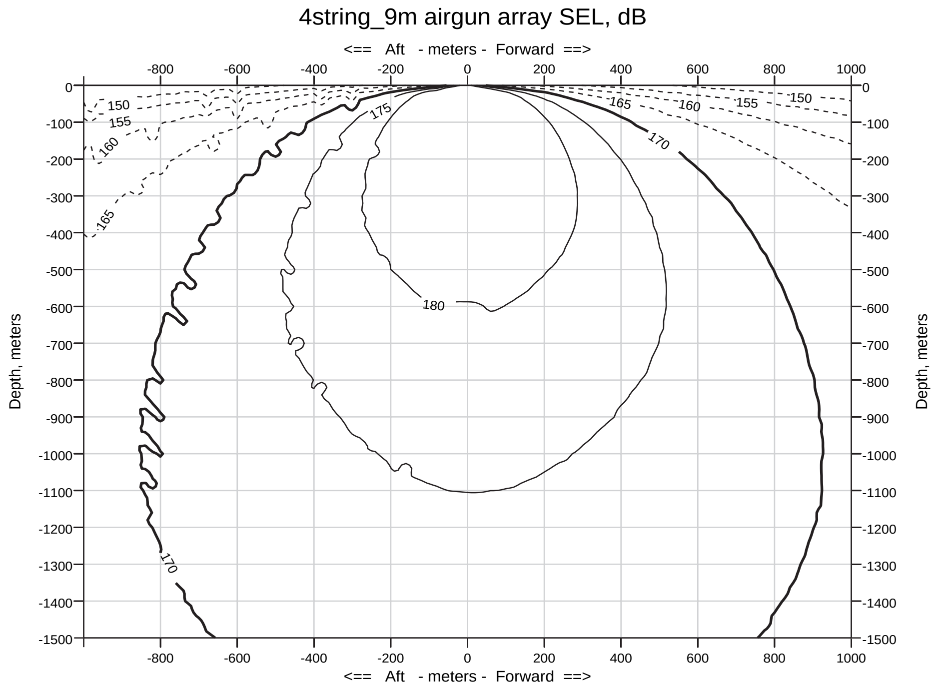
In deep and intermediate water depths, comparisons at short ranges between sound levels for direct arrivals recorded by the calibration hydrophone and model results for the same array tow depth are in good agreement (Figs. 12 and 14 in Appendix H of the PEIS). As a consequence, isopleths falling within this domain can be reliably predicted by the L-DEO model, although they may be imperfectly sampled by measurements recorded at a single depth. At larger distances, the calibration data show that seafloor-reflected and sub-seafloor-refracted arrivals dominate, whereas the direct arrivals become weak and/or incoherent (Figs. 11, 12, and 16 in Appendix H of the PEIS). Aside from local topography effects, the region around the critical distance (~5 km in Figs. 11 and 12, and ~4 km in Fig. 16 in Appendix H of the PEIS) is where the observed levels rise very close to the mitigation model curve. However, the observed sound levels are found to fall almost entirely below the mitigation model curve (Figs. 11, 12, and 16 in Appendix H of the PEIS). Thus, analysis of the GoM calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for estimating mitigation radii.

In shallow water (<100 m), the depth of the calibration hydrophone (18 m) used during the GoM calibration survey was appropriate to sample the maximum sound level in the water column, and the field measurements reported in Table 1 of Tolstoy et al. (2009) for the 36-airgun array at a tow depth of 6 m can be used to derive mitigation radii.

The proposed survey on the ENAM off Cape Hatteras would acquire data with the 36-airgun array at a tow depth of 9 m, and the 18-airgun array at a tow depth of 6 m. For deep water (>1000 m), we usethe deep-water radii obtained from L-DEO model results down to a maximum water depth of 2000 m (Figs. 2 and 3). The radii for intermediate water depths (100–1000 m) are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (Fig. 16 in Appendix H of the PEIS). For the 18-airgun array, the shallow-water radii are the empirically derived measurements from the GoM calibration survey (Fig. 5a in Appendix H of the PEIS), which are 1097 m for 170 dB SEL (proxy for 180 dB RMS) and 15.28 km for 150 dB SEL (proxy for 160 dB RMS), respectively. For the 36-airgun array, the shallow-water radii are obtained by scaling the empirically derived measurements from the GoM calibration survey to account for the difference in tow depth between the calibration survey (6 m) and the proposed survey (9 m). A simple scaling factor is calculated from the ratios of the isopleths calculated by the deep-water L-DEO model, which are essentially a measure of the energy radiated by the source array: the 150-decibel (dB) Sound Exposure Level (SEL)[1] corresponds to a deep-water radius of 9334 m for 9-m tow depth (Fig. 2) and 7244 m for 6-m tow depth (Fig. 4), yielding a scaling factor of 1.29 to be applied to the

[1] SEL (measured in dB re 1 μPa$^2 \cdot$ s) is a measure of the received energy in the pulse and represents the SPL that would be measured if the pulse energy were spread evenly across a 1-s period. Because actual seismic pulses are less than 1 s in duration in most situations, this means that the SEL value for a given pulse is usually lower than the SPL calculated for the actual duration of the pulse. In this EA, we assume that rms pressure levels of received seismic pulses would be 10 dB higher than the SEL values predicted by L-DEO's model.

shallow-water 6-m tow depth results. Similarly, the 170 dB SEL corresponds to a deep-water radius of 927 m for 9-m tow depth (Fig. 2) and 719 m for 6-m tow depth (Fig. 4), yielding the same 1.29 scaling factor. Measured 160 and 180 dB re 1µPa_{rms} distances in shallow water for the 36-gun array towed at 6 m depth were 17.5 km and 1.6 km, respectively, based on a 95th percentile fit (Tolstoy et al. 2009, Table 1).



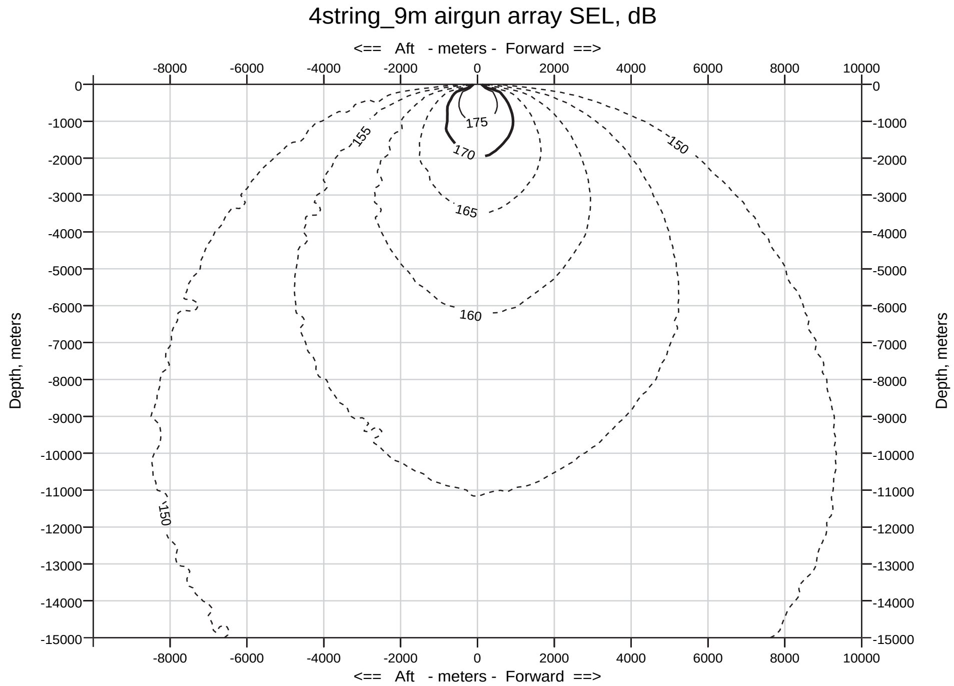
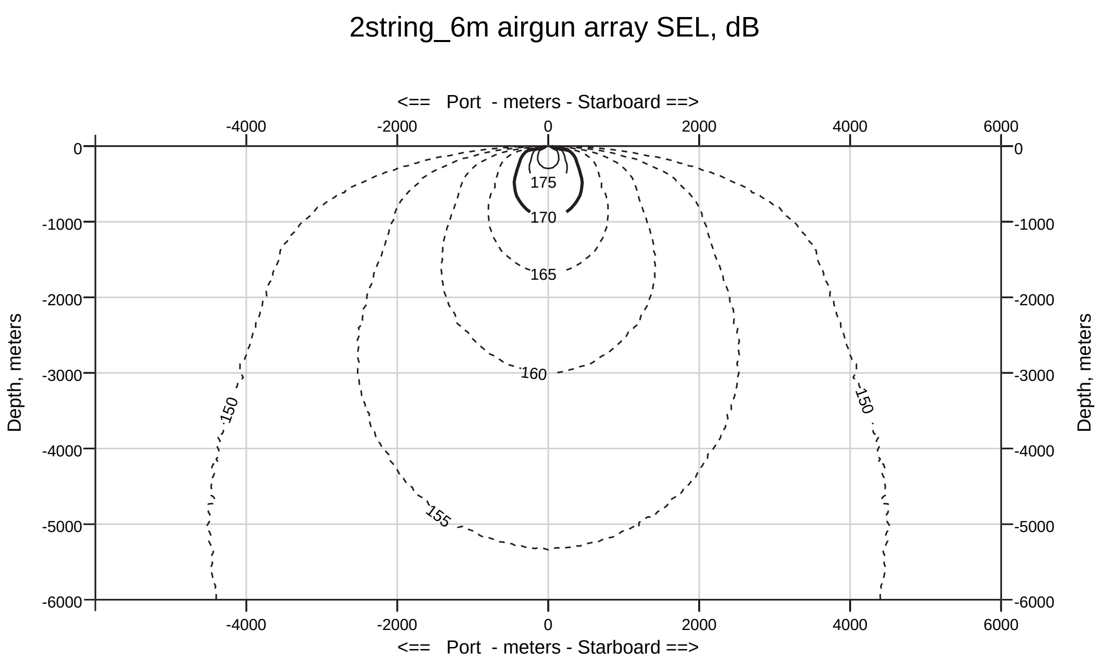


FIGURE 2. Modeled deep-water received sound levels (SELs) from the 36-airgun array planned for use during the survey off Cape Hatteras, at a 9-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.



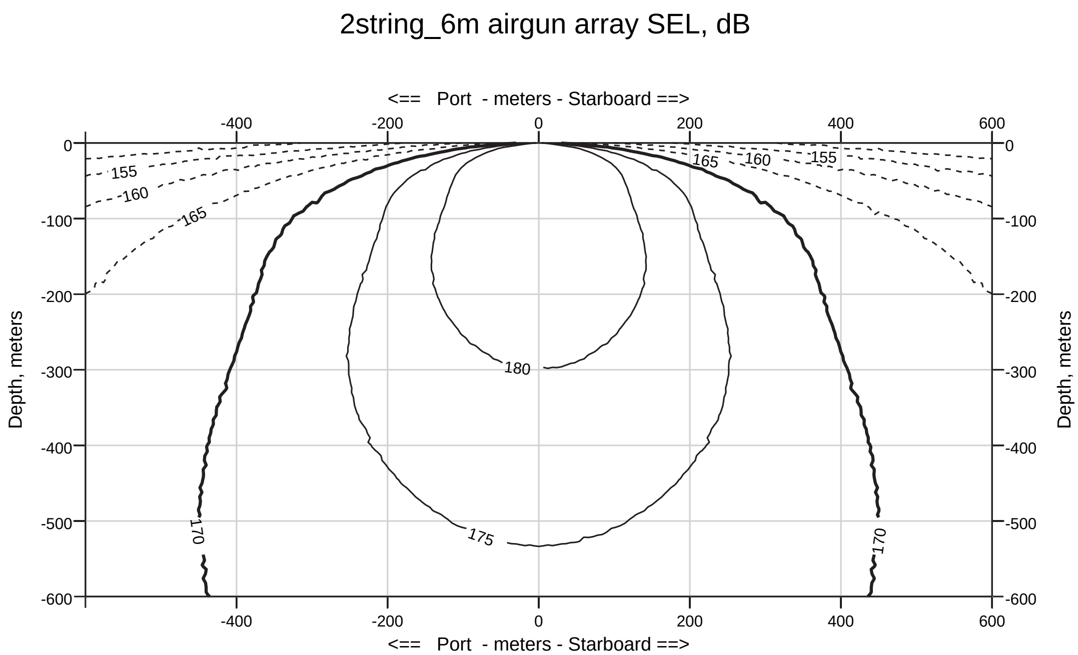
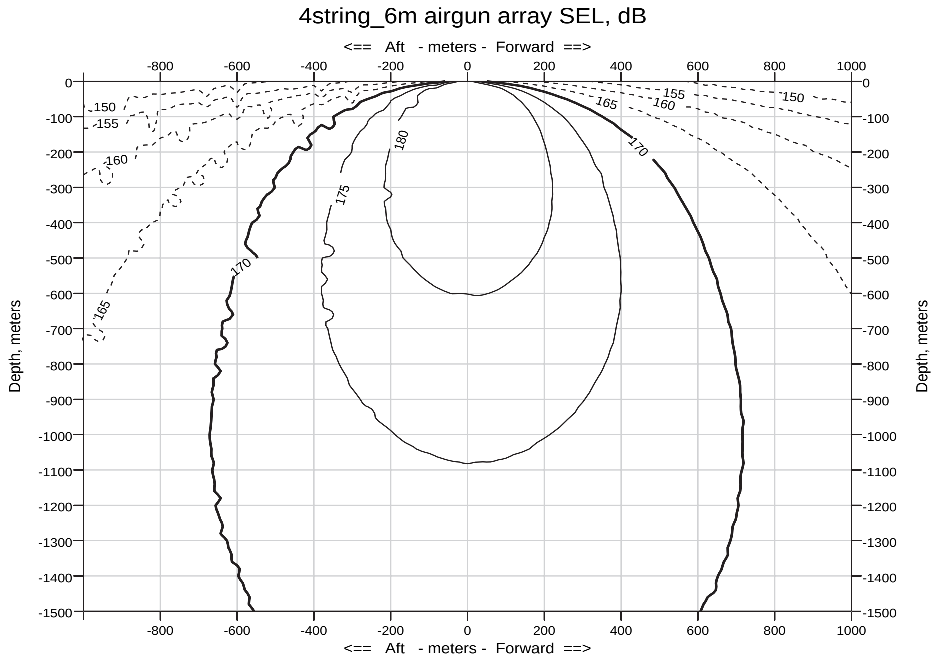


FIGURE 3. Modeled deep-water received sound levels (SELs) from the 18-airgun array planned for use during the survey off Cape Hatteras, at a 6-m tow depth. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170-dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

Multiplying by 1.29 to account for the tow depth difference yields distances of 22.6 km and 2.1 km, respectively.



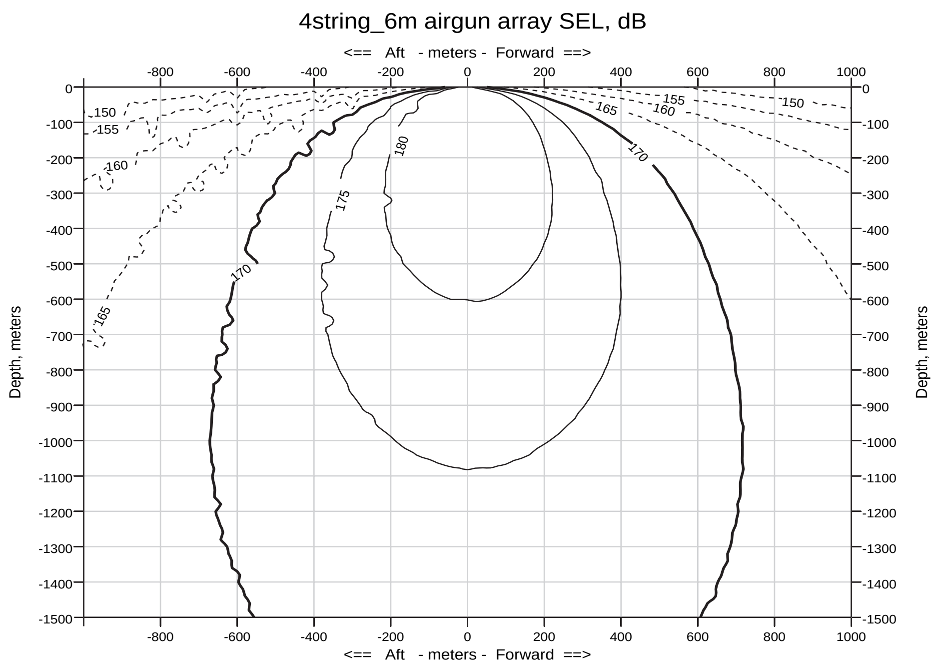


FIGURE 4. Modeled deep-water received sound levels (SELs) from the 36-airgun array at a 6-m tow depth used during the GoM calibration survey. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to the 170 dB SEL isopleth as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

Measurements have not been reported for the single 40-in^3 airgun. The 40-in^3 airgun fits under the PEIS low-energy sources. In § 2.4.2 of the PEIS, Alternative B (the Preferred Alternative) conservatively applies a 180 dB_{rms} exclusion zone (EZ) of 100 m for all low-energy acoustic sources in water depths >100 m. This approach is adopted here for the single Bolt 1900LL 40-in^3 airgun that would be used during power downs. L-DEO model results are used to determine the 160-dB radius for the 40-in^3 airgun in deep water (Fig.5). For intermediate-water depths, a correction factor of 1.5 was applied to the deep-water model results. For shallow water, a scaling of the field measurements obtained for the 36-gun array is used: the 150-dB SEL level corresponds to a deep-water radius of 388 m for the 40-in^3 airgun at 9-m tow depth (Fig. 4) and 7244 for the 36-gun array at 6-m tow depth (Fig. 2), yielding a scaling factor of 0.0536. Similarly, the 170-dB SEL level corresponds to a deep-water radius of 39 m for the 40-in^3 airgun at 9-m tow depth (Fig. 4) and 719 m for the 36-gun array at 6-m tow depth (Fig. 2), yielding a scaling factor of 0.0542. Measured 160- and 180-dB re 1μPa_{rms} distances in shallow water for the 36-gun array towed at 6-m depth were 17.5 km and 1.6 km, respectively, based on a 95th percentile fit (Tolstoy et al. 2009, Table 1). Multiplying by 0.0536 and 0.0542 to account for the difference in array sizes and tow depths yields distances of 938 m and 86 m, respectively.

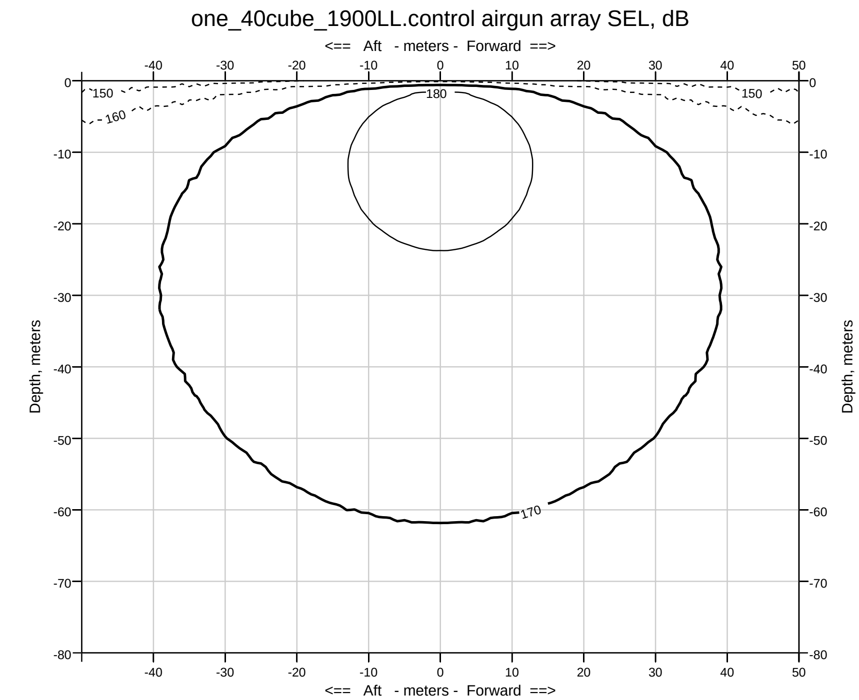
Table 1 shows the distances at which the 160- and 180- dB re 1μPa_{rms} sound levels are expected to be received for the 36-airgun array, the 18-airgun array, and the single (mitigation) airgun. The 180-dB re 1 μPa_{rms} distance is the safety criterion as specified by NMFS (2000) for cetaceans. Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In December 2013, NOAA published draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013a), although at the time of preparation of this Draft EA, the date of release of the final guidelines and how they will be implemented are unknown. As such, this Draft EA has been prepared in accordance with the current NOAA acoustic practices, and the procedures are based on best practices noted by Pierson et al. (1998) and Weir and Dolman (2007).

TABLE 1. Predicted distances to which sound levels ≥180- and 160-dB re 1 μPa_{rms} are expected to be received during the proposed survey off Cape Hatteras in September–October 2014. For the single mitigation airgun, the EZ is the conservative EZ for all low-energy acoustic sources in water depths >100 m defined in the PEIS.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted rms Radii (m)	
			180 dB	160 dB
Single Bolt airgun, 40 in^3	6 or 9	>1000 m	100	388[1]
		100–1000 m	100	582[2]
		<100 m	86[3]	938[3]
4 strings, 36 airguns, 6600 in^3	9	>1000 m	927[1]	5780[1]
		100–1000 m	1391[2]	8670[2]
		<100 m	2060[3]	22,600[3]
2 strings, 18 airguns, 3300 in^3	6	> 1000 m	450[1]	3760[1]
		100-1000 m	675[2]	5640[2]
		< 100 m	1097[4]	15,280[4]

[1] Distance is based on L-DEO model results

[2] Distance is based on L-DEO model results with a 1.5 x correction factor between deep and intermediate water depths
[3] Distance is based on empirically derived measurements in the GoM with scaling applied to account for differences in tow depth
[4] Distance is based on empirically derived measurements in the GoM



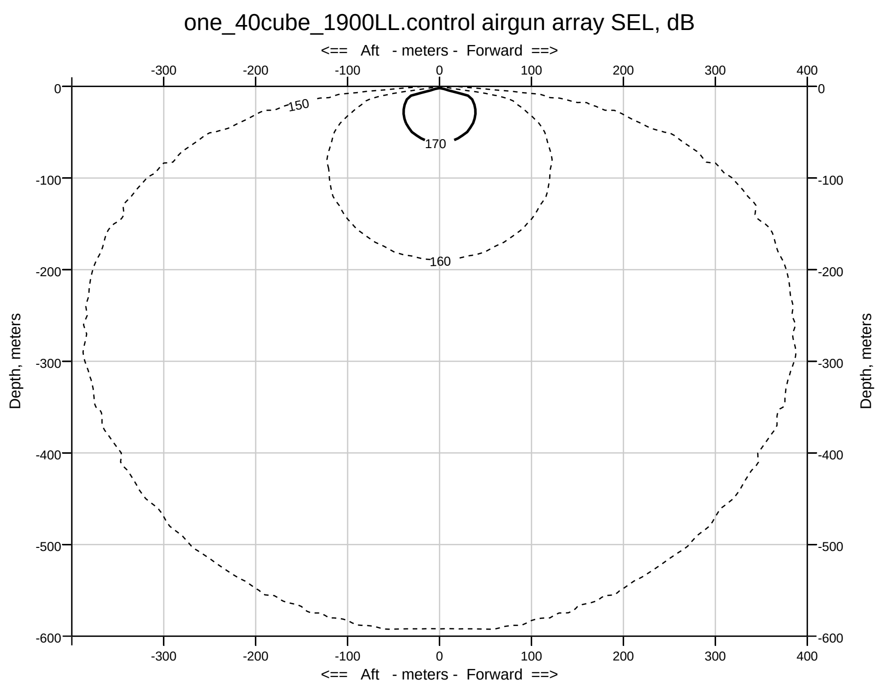


FIGURE 5. Modeled deep-water received sound levels (SELs) from a single 40-in^3 airgun towed at 9 m depth, which is planned for use as a mitigation gun during the proposed survey off Cape Hatteras. Received rms levels (SPLs) are expected to be ~10 dB higher. The plot at the top provides the radius to

the 170-dB SEL isopleths as a proxy for the 180-dB rms isopleth, and the plot at the bottom provides the radius to the 150-dB SEL isopleth as a proxy for the 160-dB rms isopleth.

The 180-dB distance would also be used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects per the IHAs. Enforcement of mitigation zones via power and shut downs would be implemented in the Operational Phase, as described in § XI.

Description of Operations

The procedures to be used for the marine geophysical survey would be similar to those used during previous surveys by L-DEO and would use conventional seismic methodology. The survey would involve one source vessel, the *Langseth*, supported by a chase vessel. The *Langseth* would deploy an array of 36 airguns as an energy source with a total volume of ~6600 in^3 or an array of 18 airguns with a total discharge volume of ~3300 in^3. The receiving system would consist of an 8-km hydrophone streamer or 90 ocean bottom seismometers (OBSs). The OBSs would be deployed and retrieved by a second vessel, the R/V *Endeavor*. As the airgun array is towed along the survey lines, the hydrophone streamer would receive the returning acoustic signals and transfer the data to the on-board processing system. The OBSs record the returning acoustic signals internally for later analysis.

A total of ~5000 km of 2-D survey lines, including turns (~3650 km MCS and ~1350 km OBS lines) are oriented perpendicular to and parallel to shore (Fig. 1). The OBS lines would be shot a second time with the streamer, for a total of ~6350 km. There would be additional seismic operations in the survey area associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard. In our calculations (see § VII), 25% has been added for those additional operations.

In addition to the operations of the airgun array, a Kongsberg EM 122 multibeam echosounder (MBES) and a Knudsen Chirp 3260 sub-bottom profiler (SBP) will also be operated from the *Langseth* continuously throughout the survey. These sources are described in § 2.2.3.1 of the PEIS. Currents would be measured with a Teledyne OS75 75-kHz ADCP. The ADCP is configured as a 4-beam phased array with a beam angle of 30°. The source level is proprietary information. The PEIS stated that ADCPs (makes and models not specified) had a maximum acoustic source level of 224 dB re 1µPa · m.

II. Dates, Duration, and Region of Activity

The date(s) and duration of such activity and the specific geographical region where it will occur.

The proposed survey area is located between ~32–37°N and ~71.5–77°W in the Atlantic Ocean ~17–422 km off the coast of Cape Hatteras (Fig. 1). Water depths in the survey area are ~20–5300 m. The seismic survey would be conducted outside of state waters and and mostly within the U.S. EEZ, and partly in International Waters. from Norfolk, Virginia, on 15 September and spend one day in transit to the proposed survey area. Setup, deployment, and streamer ballasting would take ~3 days. The seismic survey would take ~33 days, and the *Langseth* would spend one day for gear retrieval and transit back to Norfolk, arriving on 22 October. Some minor deviation from these dates would be possible, depending on logistics and weather. However, no acivities would proceed after the beginning of November to avoid the right whale migration period.

III. SPECIES AND NUMBERS OF MARINE MAMMALS IN AREA

The species and numbers of marine mammals likely to be found within the activity area

Thirty-one marine mammal species could occur near the proposed survey area. To avoid redundancy, we have included the required information about the species and (insofar as it is known) numbers of these species in § IV, below.

IV. STATUS, DISTRIBUTION AND SEASONAL DISTRIBUTION OF AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities

Sections III and IV are integrated here to minimize repetition.

Thirty-one cetacean species (6 mysticetes and 25 odontocetes) could occur near the proposed survey site (Table 3). Six of the 31 species are listed under the U.S. Endangered Species Act (ESA) as ***Endangered***: the North Atlantic right, humpback, blue, fin, sei, and sperm whales. Bryde's whale (*Balaenoptera brydei*) likely would not occur near the proposed survey area, because its distribution generally does not extend as far north as ~32–37°N. An additional three cetacean species, although present in the wider western North Atlantic Ocean, likely would not be found near the proposed survey area because their ranges generally do not extend as far south (northern bottlenose whale, *Hyperoodon ampullatus*; Sowerby's beaked whale, *Mesoplodon bidens*; and white-beaked dolphin, *Lagenorhynchus albirostris*).

Similarly, no pinnipeds are included; harp seals (*Pagophilus groenlandicus*) and hooded seals (*Cystophora cristata*) are rare in the proposed survey area, and gray (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*) have a more northerly distribution during the summer (DoN 2005) and are not expected to occur there during the survey.

General information on the taxonomy, ecology, distribution and movements, and acoustic capabilities of marine mammals are given in § 3.6.1 and § 3.7.1 of the PEIS. The general distributions of mysticetes and odontocetes in this region of the Northwest Atlantic Ocean are discussed in § 3.6.2.1 and § 3.7.2.1 of the PEIS, respectively. Additionally, information on marine mammals in this region is included in § 4.2.2.1 of the Bureau of Ocean Energy Management (BOEM) draft PEIS for Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas (BOEM 2012), and in § 3.7.2 of the Final EIS/OEIS for the Virginia Capes and the Cherry Point Range Complexes (DoN 2009a,b). The rest of this section focuses on species distribution in and near the proposed survey area off the coasts of Virginia and North Carolina.

The main sources of information used here are the 2010 and 2012 U.S. Atlantic and Gulf of Mexico marine mammal stock assessment reports (SARs: Waring et al. 2010, 2013), the Ocean Biogeographic Information System (OBIS: IOC 2013), and the Cetacean and Turtle Assessment Program (CETAP 1982). The SARs include maps of sightings for most species from NMFS' Northeast and Southeast Fisheries Science Centers (NEFSC and SEFSC) surveys in summer 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, and 2011. OBIS is a global database of marine species sightings. CETAP covered 424,320 km of trackline on the U.S. outer continental shelf from Cape Hatteras to Nova Scotia. Aerial and shipboard surveys were conducted over a 39-month period from 1 November 1978 to 28 January 1982. The mid-Atlantic area referred to in the following species accounts included waters south of Georges Bank down to Cape Hatteras, and from the coast out to ~1830 m depth.

Mysticetes

North Atlantic Right Whale (*Eubalaena glacialis*)

The North Atlantic right whale is known to occur primarily in the continental shelf waters off the eastern U.S. and Canada, from Florida to Nova Scotia (Winn et al. 1986; Jefferson et al. 2008). There are five well-known habitats in the northwest Atlantic used annually by right whales (Winn et al. 1986; NMFS 2005). These include the winter calving grounds in coastal waters of the southeastern U.S.

TABLE 2. The habitat, occurrence, regional population sizes, and conservation status of marine mammals that could occur in or near the proposed survey area in the Northwest Atlantic Ocean.

Species	Habitat	Occurrence in survey area in fall	Regional/SAR abundance estimates[1]	ESA[2]	IUCN[3]	CITES[4]
Mysticetes						
North Atlantic right whale	Coastal and shelf	Rare	455 / 455[5]	EN	EN	I
Humpback whale	Mainly nearshore, banks; pelagic	Uncommon	11,600[6] / 823[7]	EN	LC	I
Minke whale	Mainly coastal	Uncommon	138,000[8] / 20,741[9]	NL	LC	I
Sei whale	Mainly offshore	Rare	10,300[10] / 357[11]	EN	EN	I
Fin whale	Slope, pelagic	Uncommon	26,500[12] / 3522[5]	EN	EN	I
Blue whale	Shelf, pelagic	Rare	855[13] / 440[5]	EN	EN	I
Odontocetes						
Sperm whale	Pelagic	Common	13,190[14] / 2288[15]	EN	VU	I
Pygmy sperm whale	Off shelf	Uncommon	N.A. / 3785[16]	NL	DD	II
Dwarf sperm whale	Off shelf	Uncommon	N.A. / 3785[16]	NL	DD	II
Cuvier's beaked whale	Pelagic	Uncommon	N.A. / 6532[5]	NL	LC	II
True's beaked whale	Pelagic	Rare	N.A. / 7092[17]	NL	DD	II
Gervais' beaked whale	Pelagic	Rare	N.A. / 7092[17]	NL	DD	II
Blainville's beaked whale	Pelagic	Rare	N.A. / 7092[17]	NL	DD	II
Rough-toothed dolphin	Mainly pelagic	Uncommon	N.A. / 271[5]	NL	LC	II
Bottlenose dolphin	Coastal, offshore	Common	N.A. / 86,705[18]	NL^	LC	II
Pantropical spotted dolphin	Mainly pelagic	Common	N.A. / 3333[5]	NL	LC	II
Atlantic spotted dolphin	Shelf, slope, pelagic	Common	N.A. / 44,715[5]	NL	DD	II
Spinner dolphin	Coastal, pelagic	Rare	N.A. / N.A.	NL	DD	II
Striped dolphin	Off shelf	Common	N.A. / 54,807[5]	NL	LC	II
Clymene dolphin	Pelagic	Uncommon	N.A. / N.A.	NL	DD	II
Short-beaked common dolphin	Shelf, pelagic	Common	N.A. / 173,486[5]	NL	LC	II
Atlantic white-sided dolphin	Shelf and slope	Rare	10s to 100s of 1000s[19] / 48,819[5]	NL	LC	II
Fraser's dolphin	Pelagic	Rare	N.A. / N.A.	NL	LC	II
Risso's dolphin	Mainly shelf, slope	Common	N.A. /18,250[5]	NL	LC	II
Melon-headed whale	Mainly pelagic	Rare	N.A. / N.A.	NL	LC	II
False killer whale	Pelagic	Rare	N.A. / N.A.	NL	DD	II
Pygmy killer whale	Mainly pelagic	Rare	N.A. / N.A.	NL	DD	II
Killer whale	Coastal	Rare	N.A. / N.A.	NL*	DD	II
Long-finned pilot whale	Mainly pelagic	Common	780K[20] / 26,535[5]	NL[†]	DD	II
Short-finned pilot whale	Mainly pelagic	Common	780K[20] / 21,515[5]	NL	DD	II
Harbor porpoise	Coastal	Rare	~500K[21] / 79,883[22]	NL	LC	II

N.A. = Data not available

[1] SAR (stock assessment report) abundance estimates are from the 2012 U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments (Waring et al. 2013) as noted, and regional abundance estimates are for the North Atlantic regions as noted.

[2] U.S. Endangered Species Act; EN = Endangered, NL = Not listed

[3] Codes for IUCN classifications from IUCN Red List of Threatened Species (IUCN 2013): EN = Endangered; VU = Vulnerable; LC = Least Concern; DD = Data Deficient

[4] Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2013): Appendix I = Threatened with extinction; Appendix II = not necessarily now threatened with extinction but may become so unless trade is closely controlled

[5] Estimate for the Western North Atlantic Stock (Waring et al. 2013)

[6] Best estimate for the western North Atlantic in 1992–1993 (IWC 2013)
[7] Minimum estimate for the Gulf of Maine stock (Waring et al. 2013)
[8] Best estimate for the North Atlantic in 2002–2007 (IWC 2013)
[9] Estimate for the Canadian East Coast Stock (Waring et al. 2013)
[10] Estimate for the Northeast Atlantic in 1989 (Cattanach et al. 1993)
[11] Estimate for the Nova Scotia Stock (Waring et al. 2013)
[12] Best estimate for the North Atlantic in 2007 (IWC 2013)
[13] Estimate for the central and northeast Atlantic in 2001 (Pike et al. 2009)
[14] Estimate for the North Atlantic (Whitehead 2002)
[15] Estimate for the North Atlantic Stock (Waring et al. 2013)
[16] Combined estimate for pygmy and dwarf sperm whales (Waring et al. 2013)
[17] Combined estimate for *Mesoplodon* spp. (Waring et al. 2013)
[18] Combined estimate for the Western North Atlantic Offshore Stock and the Southern Migratory Coastal Stock (Waring et al. 2013)
[19] Tens to low hundreds of thousands in the North Atlantic (Reeves et al. 1999)
[20] Estimate for both long- and short-finned pilot whales in the central and eastern North Atlantic in 1989 (IWC 2013)
[21] Estimate for the North Atlantic (Jefferson et al. 2008)
[22] Estimate for the Gulf of Maine/Bay of Fundy Stock (Waring et al. 2013)
* Killer whales in the eastern Pacific Ocean, near Washington state, are listed as endangered under the U.S. ESA but not in the Atlantic Ocean.
^ The Western North Atlantic Coastal Morphotype stocks, ranging from NJ to FL, are listed as depleted under the U.S. Marine Mammal Protection Act, as are some other stocks to the south of the proposed survey area.
† Considered a strategic stock.

(Florida/Georgia); spring feeding grounds in the Great South Channel (east of Cape Cod); late winter/spring feeding grounds and nursery grounds in Massachusetts Bay and Cape Cod Bay; summer/fall feeding and nursery grounds in the Bay of Fundy; and summer/fall feeding grounds on the Nova Scotian Shelf. In addition, Jeffreys Ledge, off the coast of northern Massachusetts, New Hampshire, and Maine, could be an important fall feeding area for right whales and an important nursery area during summer, especially in July and August (Weinrich et al. 2000). The first three habitats were designated as Critical Habitat Areas by NMFS (1994).

There is a general seasonal north-south migration of the North Atlantic population between feeding and calving areas, but right whales could be seen anywhere off the Atlantic U.S. throughout the year (Gaskin 1982). The migration route between the Cape Cod summer feeding grounds and the Georgia/Florida winter calving grounds, known as the mid-Atlantic corridor, has not been considered to include “high use” areas, yet the whales clearly move through these waters regularly in all seasons (Reeves and Mitchell 1986; Winn et al. 1986; Kenney et al. 2001; Reeves 2001; Knowlton et al. 2002; Whitt et al. 2013).

North Atlantic right whales are found commonly on the northern feeding grounds off the north-eastern U.S. during early spring and summer. The highest abundance in Cape Cod Bay is in February and April (Winn et al. 1986; Hamilton and Mayo 1990) and from April to June in the Great South Channel east of Cape Cod (Winn et al. 1986; Kenney et al. 1995). Throughout the remainder of summer and into fall (June–November), they are most commonly seen farther north on feeding grounds in Canadian waters, with a peak abundance during August, September, and early October (Gaskin 1987). Morano et al. (2012) and Mussoline et al. (2012) indicated that right whales are present in the southern Gulf of Maine year-round and that they occur there over longer periods than previously thought.

Some whales, including mothers and calves, remain on the feeding grounds through the fall and winter. However, the majority of the right whale population leaves the feeding grounds for unknown wintering habitats and returns when the cow-calf pairs return. The majority of the right whale population is unaccounted for on the southeastern U.S. winter calving ground, and not all reproductively-active females return to the area each year (Kraus et al. 1986; Winn et al. 1986; Kenney et al. 2001). Other wintering areas have been suggested, based upon sparse data or historical whaling logbooks; these include the Gulf of St. Lawrence, Newfoundland and Labrador, coastal waters of New York and between New Jersey and North Carolina, Bermuda, and Mexico (Payne and McVay 1971; Aguilar 1986; Mead 1986; Lien et al. 1989; Knowlton et al. 1992; Cole et al. 2009; Patrician et al. 2009).

Knowlton et al. (2002) provided an extensive and detailed analysis of survey data, satellite tag data, whale strandings, and opportunistic sightings along State waters of the mid-Atlantic migratory corridor[2], from the border of Georgia/South Carolina to south of New England, spanning the period from 1974 to 2002. The majority of sightings (94%) along the migration corridor were within 56 km of shore, and more than half (64%) were within 18.5 km of shore (Knowlton et al. 2002). Water depth preference was for shallow waters; 80% of all sightings were in depths <27 m, and 93% were in depths <45 m (Knowlton et al. 2002). Most sightings farther than 56 km from shore occurred at the northern end of the corridor, off New York and south of New England. North of Cape Hatteras, most sightings were reported for March–April; south of Cape Hatteras, most sightings occurred during February–April (Knowlton et al. 2002). Similarly, sighting data analyzed by Winn et al. (1986) dating back to 1965 showed that the occurrence of North Atlantic right whales in the Cape Hatteras region, including the proposed survey area, peaked in March; in the mid-Atlantic area, it peaked in April.

A review of the mid-Atlantic whale sighting and tracking data archive from 1974 to 2002 showed North Atlantic right whale sightings off the coasts of Virginia and North Carolina during fall, winter, and spring; there were no sightings for July–September (Beaudin Ring 2002). Three sightings were reported for the month of October near the coast of North Carolina; there were no sightings off Virginia during October (Beaudin Ring 2002). Right whale sighting data mapped by DoN (2008a,b) showed the greatest occurrence off Virginia and North Carolina during the winter (December–April), with many fewer sightings during spring and fall.

The Interactive North Atlantic Right Whale Sighting Map showed 30 sightings in the shelf waters off Virginia and North Carolina between 2005 and 2013, and one sighting seaward of the shelf off Virginia (NEFSC 2013). All sightings were made from December through July, and six sightings were made within the proposed survey area during 2013. There are 69 sightings of right whales off Virginia/ North Carolina in OBIS (IOC 2013) including sightings made during the 1978–1982 CETAP surveys (CETAP 1982); none of the OBIS sightings were made during September or October.

Palka (2006) reviewed North Atlantic right whale density in the U.S. Navy Northeast Operating Area based on summer abundance surveys conducted during 1998–2004. One of the lowest whale densities (including right whales) was found in the mid-Atlantic stratum, which included the waters off Virginia. However, survey effort for this stratum was also the lowest; only two surveys were conducted. No right whales were sighted.

Whitt et al. (2013) surveyed for right whales off the coast of New Jersey using acoustic and visual techniques from January 2008 to December 2009. Whale calls were detected off New Jersey year-round and four sightings were made from November to January. In light of these findings, Whitt et al. (2013) suggested expanding the existing critical habitat to include waters of the mid Atlantic. NMFS (2010) previously noted that such a revision could be warranted, but no revisions have been made to the critical habitat yet.

---

[2] Multi-year datasets for the analysis were provided by the New England Aquarium (NEAQ), North Atlantic Right Whale Consortium (NARWC), Oregon State University, Coastwise Consulting Inc, Georgia Department of Natural Resources, University of North Carolina Wilmington (UNCW), Continental Shelf Associates, Cetacean and Turtle Assessment Program (CETAP), NOAA, and University of Rhode Island.

North Atlantic right whales likely would not be encountered at the time of the proposed survey.

Federal and Other Action.—In 2002, NMFS received a petition to revise and expand the designation of critical habitat for the North Atlantic right whale. The revision was declined and the critical habitat designated in 1994 remained in place (NMFS 2005). Another petition for a revision to the critical habitat was received in 2009, which sought to expand the currently designated critical feeding and calving habitat areas and include a migratory corridor as critical habitat (NMFS 2010). NMFS noted that the requested revision may be warranted, but no revisions have been made as of September 2013. The designation of critical habitat does not restrict activities within the area or mandate any specific management action. However, actions authorized, funded, or carried out by Federal agencies that may have an impact on critical habitat must be consulted upon in accordance with Section 7 of the ESA, regardless of the presence of right whales at the time of impacts. Impacts on these areas that could affect primary constituent elements such as prey availability and the quality of nursery areas must be considered when analyzing whether habitat may be adversely modified.

A number of other actions have been taken to protect North Atlantic right whales, including establishing the Right Whale Sighting Advisory System designed to reduce collisions between ships and right whales by alerting mariners to the presence of the whales (see NEFSC 2012); a Mandatory Ship Reporting System implemented by the U.S. Coast Guard in the right whale nursery and feeding areas (USCG 1999, 2001; Ward-Geiger et al. 2005); recommended shipping routes in key right whale aggregation areas (NOAA 2006, 2007); and regulations to implement seasonal mandatory vessel speed restrictions in specific locations (Seasonal Management Areas) during times when whales are likely present, including ~37 km around points near the mouth of Chesapeake Bay (37.006ºN, 75.964ºW) and the Ports of Morehead City and Beaufort, NC (34.962ºN, 76.669ºW) during 1 November–30 April (NMFS 2008). Furthermore, the Bureau of Ocean Energy Management (BOEM) proposed that no seismic surveys would be authorized within right whale critical habitat areas in its draft PEIS (BOEM 2012). The proposed survey area is not in any of these areas.

Humpback Whale (*Megaptera novaeangliae*)

Although considered to be mainly a coastal species, humpback whales often traverse deep pelagic areas while migrating (e.g., Calambokidis et al. 2001). In the North Atlantic, a Gulf of Maine stock of the humpback whale is recognized off the northeastern U.S. coast as a distinct feeding stock (Palsbøll et al. 2001; Vigness-Raposa et al. 2010). Whales from this stock feed during spring, summer, and fall in areas ranging from Cape Cod to Newfoundland. In spring and summer, the greatest concentrations of humpback whales occur in the southern Gulf of Maine and east of Cape Cod, with a few sightings ranging south to North Carolina (Clapham et al. 1993; DoN 2005). Similar distribution patterns are seen in fall, although with fewer sightings. Off Virginia and North Carolina, most sightings mapped by DoN (2008a,b) are in winter, mostly nearshore; there were fewer in spring, most along the shelf break or in deep, offshore water; none in summer, and five in fall, mostly nearshore. During CETAP surveys, three sightings of humpbacks where made off Virginia: one each during spring, fall, and winter (CETAP 1982). There are 63 OBIS sighting records of humpback whales in and near the proposed survey area off the coasts of Virginia and North Carolina; most sightings were made over the continental shelf (IOC 2013).

Common Minke Whale (*Balaenoptera acutorostrata*)

Four populations of the minke whale are recognized in the North Atlantic, including the Canadian East Coast stock that ranges from the eastern U.S. coast to Davis Strait (Waring et al. 2013). Minke whales are common off the U.S. east coast over continental shelf waters, especially off New England during spring and summer (CETAP 1982; DoN 2005). Seasonal movements in the northwest Atlantic are apparent, with animals moving south and offshore from New England waters during winter (DoN 2005; Waring et al. 2013). Sightings off Virginia and North Carolina are less common; 15 sightings were mapped by DoN (2008a,b), most in winter and spring with 1 in summer and 1 in fall, and most on the shelf or near the shelf break. There are ~17 OBIS sighting records of minke whales for the shelf waters off Virginia and North Carolina and another two sightings in deep offshore waters (IOC 2013); half the sightings were made during spring and summer CETAP surveys (CETAP 1982).

Sei Whale (*Balaenoptera borealis*)

Two stocks of the sei whale are recognized in the North Atlantic: the Labrador Sea Stock and the Nova Scotia Stock; the latter has a distribution that includes continental shelf waters from the northeastern U.S. to areas south of Newfoundland (Waring et al. 2013). The southern portion of the Nova Scotia stock's range includes the Gulf of Maine and Georges Bank during spring and summer (Waring et al. 2013). Peak sightings occur in spring and are concentrated along the eastern edge of Georges Bank into the Northeast Channel and the southwestern edge of Georges Bank (DoN 2005; Waring et al. 2013). Mitchell and Chapman (1977) suggested that this stock moves from spring feeding grounds on or near Georges Bank to the Scotian Shelf in June and July, eastward to Newfoundland and the Grand Banks in late summer, back to the Scotian Shelf in fall, and offshore and south in winter. During summer and fall, most sei whale sightings occur in feeding grounds in the Bay of Fundy and on the Scotian Shelf; sightings south of Cape Cod are rare (DoN 2005). DoN (2008a) reported only six sightings off Virginia and North Carolina, all during winter and spring, and all north of Cape Hatteras. There are two OBIS sightings of sei whales off North Carolina (IOC 2013), including one in deep offshore water that was made during a CETAP survey in 1980 (CETAP 1982) and one on the shelf. Sei whales likely would not be encountered during the proposed survey.

Fin Whale (*Balaenoptera physalus*)

The fin whale is present in U.S. shelf waters during winter, and is sighted more frequently than any other large whale at this time (DoN 2005). Winter sightings are most concentrated around Georges Bank and in Cape Cod Bay. During spring and summer, most fin whale sightings are north of 40ºN, with smaller numbers on the shelf south of there (DoN 2005). During fall, almost all fin whales move out of U.S. waters to feeding grounds in the Bay of Fundy and on the Scotian Shelf, remain at Stellwagen Bank and Murray Basin (DoN 2005), or begin a southward migration (Clark 1995).

The occurrence of fin whales off Virginia and North Carolina appears to be highest during winter and spring, with more sightings close to shore during winter and farther offshore, mostly on the outer shelf and along the shelf break, during spring; only a few sightings were made in summer and fall (DoN 2008a,b). There are ~100 OBIS sightings of fin whales in and near the proposed survey area off Virginia and North Carolina, mainly in shelf waters (IOC 2013); some of these sightings were made during the CETAP surveys (CETAP 1982). Three fin whale sightings were made near the shelf break off Virginia and North Carolina on NEFSC and SEFSC summer surveys during 1995–2011 (Waring et al. 2013).

Blue Whale (*Balaenoptera musculus*)

In the western North Atlantic, the distribution of the blue whale extends as far north as Davis Strait and Baffin Bay (Sears and Perrin 2009). Little is known about the movements and wintering grounds of the stocks (Mizroch et al. 1984). The acoustic detection of blue whales using the U.S. Navy's Sound

Surveillance System (SOSUS) program has tracked blue whales throughout most of the North Atlantic, including deep waters east of the U.S. Atlantic EEZ and subtropical waters north of the West Indies (Clark 1995).

Wenzel et al. (1988) reported the occurrence of three blue whales in the Gulf of Maine in 1986 and 1987, which were the only reports of blue whales in shelf waters from Cape Hatteras to Nova Scotia. Several other sightings for the waters off the east coast of the U.S. were reported by DoN (2005). Wenzel et al. (1988) suggested that it is unlikely that blue whales occur regularly in the shelf waters off the U.S. east coast. Similarly, Waring et al. (2010) suggested that the blue whale is, at best, an occasional visitor in the U.S. Atlantic EEZ.

During the 1978–1982 CETAP surveys, the only two sightings of blue whales were made just south of Nova Scotia (CETAP 1982). Two offshore sightings of blue whales during spring have been reported just to the northeast of the proposed survey area: one off the coast of North Carolina and the other off Virginia (IOC 2013). DoN (2008a) also reported one blue whale sighting to the northeast of the proposed survey area in deep water off North Carolina during spring. Blue whales likely would not be encountered during the proposed survey.

Odontocetes

Sperm Whale (*Physeter macrocephalus*)

In the northwest Atlantic, the sperm whale generally occurs in deep water along the continental shelf break from Virginia to Georges Bank, and along the northern edge of the Gulf Stream (Waring et al. 2001). Shelf edge, oceanic waters, seamounts, and canyon shelf edges are also predicted habitats of sperm whales in the Northwest Atlantic (Waring et al. 2001). Off the eastern U.S. coast, they are also known to concentrate in regions with well-developed temperature gradients, such as along the edges of the Gulf Stream and warm core rings, which may aggregate their primary prey, squid (Jaquet 1996).

Sperm whales appear to have a well-defined seasonal cycle in the northwest Atlantic. In winter, most historical records are in waters east and northeast of Cape Hatteras, with few animals north of 40ºN; in spring, they shift the center of their distribution northward to areas east of Delaware and Virginia, but they are widespread throughout the central area of the Mid-Atlantic Bight and southern tip of Georges Bank (DoN 2005; Waring et al. 2013). During summer, they expand their spring distribution to include areas east and north of Georges Bank, the Northeast Channel, and the continental shelf south of New England (inshore of 100 m deep). By fall, sperm whales are most common south of New England on the continental shelf but also along the shelf edge in the Mid-Atlantic Bight (DoN 2005; Waring et al. 2013).

Sperm whales occur in deep, offshore waters of Virginia and North Carolina throughout the year, on the shelf, along the shelf break, and offshore, including in and near the proposed survey area; the lowest number of sightings was in fall (DoN 2008a,b). There are several hundred OBIS records of sperm whales in deep waters off Virginia and North Carolina (IOC 2013), and numerous sightings were reported on and seaward of the shelf break during CETAP surveys (CETAP 1982) and during summer NEFSC and SEFSC surveys between 1998 and 2011 (Waring et al. 2013).

Pygmy and Dwarf Sperm Whales (*Kogia breviceps and K. sima*)

In the northwest Atlantic, both pygmy and dwarf sperm whales are thought to occur as far north as the Canadian east coast, with the pygmy sperm whale ranging as far as southern Labrador; both species prefer deep, offshore waters (Jefferson et al. 2008). Between 2006 and 2010, 127 pygmy and 32 dwarf sperm whale strandings were recorded from Maine to Puerto Rico, mostly off the southeastern U.S. coast;

11 strandings of *Kogia* spp. were reported for Virginia and 48 for North Carolina (Waring et al. 2013). There are eight OBIS sightings of pygmy or dwarf sperm whales in offshore waters off Virginia and North Carolina (IOC 2013). DoN (2008a,b) mapped 22 sightings of *Kogia* spp. off Virginia and North Carolina, most in winter and spring with 2 in summer and 1 in fall, and most near the shelf break or offshore. Several sightings of *Kogia* sp. (either pygmy or dwarf sperm whales) were also reported by DoN (2008a) and Waring et al. (2013) in deep, offshore waters off Virginia and North Carolina, all in summer.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

In the northwest Atlantic, Cuvier's beaked whale has stranded and been sighted as far north as the Nova Scotian shelf, and occurs most commonly from Massachusetts to Florida (MacLeod et al. 2006). Most sightings in the northwest Atlantic occur in late spring or summer, particularly along the continental shelf edge in the mid-Atlantic region (CETAP 1982; DoN 2005; Waring et al. 2001, 2013).

Off North Carolina, 14 sightings of Cuvier's beaked whales were mapped by DoN (2008a,b), most along the shelf break or offshore; there were 7 in spring, 4 in winter, 2 in summer, and 1 in fall. Several sightings were made along the shelf break off North Carolina in the spring and summer during the 1978–1982 CETAP surveys (CETAP 1982). Palka (2012) reported one Cuvier's beaked whale sighting in deep offshore waters off Virginia during June–August 2011 surveys. There are four and nine OBIS sighting records of Cuvier's beaked whale in offshore waters off Virginia and North Carolina, respectively, including the CETAP sightings (IOC 2013).

True's Beaked Whale (*Mesoplodon mirus*)

In the Northwest Atlantic, True's beaked whale occurs from Nova Scotia to Florida and the Bahamas (Rice 1998). Carwardine (1995) suggested that this species could be associated with the Gulf Stream. One sighting was reported on the shelf break off North Carolina during spring (DoN 2008a,b), and there are three stranding records of True's beaked whale for North Carolina (DoN 2008a,b). Macleod et al. (2006) reported numerous other stranding records for the east coast of the U.S. Several sightings of unidentified beaked whales were reported off Virginia and North Carolina during summer NEFSC and SEFSC surveys between 1995 and 2011 (Waring et al. 2013). True's beaked whales likely would not be encountered during the proposed survey.

Gervais' Beaked Whale (*Mesoplodon europaeus*)

Based on stranding records, Gervais' beaked whale appears to be more common in the western Atlantic than in the eastern Atlantic (Macleod et al. 2006; Jefferson et al. 2008). Off the U.S. east coast, it occurs from Cape Cod Bay, Massachusetts (Moore et al. 2004) to Florida, with a few records in the Gulf of Mexico (Mead 1989). Numerous strandings were mapped by DoN (2008a,b) in North Carolina during all seasons, but there were no sightings. DoN (2005) also reported numerous other sightings along the shelf break off the northeast coast of the U.S. Palka (2012) reported one sighting in deep offshore waters off Virginia during June–August 2011 surveys. There are four OBIS stranding records of Gervais' beaked whale for Virginia (IOC 2013).

Blainville's Beaked Whale (*Mesoplodon densirostris*)

In the western North Atlantic, Blainville's beaked whale is found from Nova Scotia to Florida, the Bahamas, and the Gulf of Mexico (Würsig et al. 2000). There are numerous stranding records along the east coast of the U.S. (Macleod et al. 2006). DoN (2008a,b) mapped a number of strandings but no sightings of Blainville's beaked whale off Virginia or North Carolina; however, numerous sightings of unidentified beaked whales were mapped off Virginia and North Carolina by DoN (208a.b) and during summer NEFSC and SEFSC surveys between 1995 and 2011 (Waring et al. 2013). There is one OBIS sighting record in offshore waters off Virginia (IOC 2013). Blainville's beaked whales likely would not be encountered during the proposed survey.

Rough-toothed Dolphin (*Steno bredanensis*)

The rough-toothed dolphin is distributed worldwide in tropical, subtropical, and warm temperate waters (Miyazaki and Perrin 1994). It is generally seen in deep, oceanic water, although it can occur in shallow coastal waters in some locations (Jefferson et al. 2008). The rough-toothed dolphin rarely ranges north of 40°N (Jefferson et al. 2008). There are eight OBIS sighting records of rough-toothed dolphins off North Carolina (IOC 2013), including four sightings made during SEFSC surveys during 1992–1999 (Waring et al. 2010). Five of the OBIS sightings were made on the shelf, and three were made in deep, offshore water. DoN (2008a,b) reported two sightings off North Carolina, one in summer and one in fall. In addition, Palka (2012) reported three sightings in deep offshore waters off Virginia during June–August 2011 surveys.

Common Bottlenose Dolphin (*Tursiops truncatus*)

In the northwest Atlantic, the common bottlenose dolphin occurs from Nova Scotia to Florida, the Gulf of Mexico and the Caribbean, and south to Brazil (Würsig et al. 2000). There are regional and seasonal differences in the distribution of the offshore and coastal forms of bottlenose dolphins off the U.S. east coast. Although strandings of bottlenose dolphins are a regular occurrence along the U.S. east coast, since July 2013, an unusually high number of dead or dying bottlenose dolphins (almost 900 as of 24 November) have washed up on the mid-Atlantic coast from New York to Florida (NOAA 2013b). NOAA declared an unusual mortality event (UME), the tentative cause of which is thought to be cetacean morbillivirus. As of 25 November 2013, 145 of 156 dolphins tested were confirmed positive or suspect positive for morbillivirus. NOAA personnel observed that the dolphins affected live in nearshore waters, whereas dolphins in offshore waters >50 m deep did not appear to be affected (Environment News Service 2013), but have stated that it is uncertain exactly what populations have been affected (NOAA 2013b). In addition to morbillivirus, the bacteria *Brucella* was confirmed in 11 of 43 dolphins tested (NOAA 2013b). The NOAA web site is updated frequently, and it is apparent that the strandings have been extending south; in the 4 November update, dead or dying dolphins had been reported only as far south as South Carolina.

Evidence of year-round or seasonal residents and migratory groups exist for the coastal form of bottlenose dolphins, with the so-called "northern migratory management unit" occurring from north of Cape Hatteras to New Jersey, but only during summer and in waters <25 m deep (Waring et al. 2010). The offshore form appears to be most abundant along the shelf break and is differentiated from the coastal form by occurring in waters typically >40 m deep (Waring et al. 2010). Bottlenose dolphin records in the northwest Atlantic suggest that they generally can occur year-round from the continental shelf to deeper waters over the abyssal plain, from the Scotian Shelf to North Carolina (DoN 2005, 2008a,b).

Palka (2012) reported several sightings off Virginia in water depths >2000 m during June–August 2011 surveys. There are also several thousand OBIS records for waters off Virginia and North Carolina, including sightings in the proposed survey area on the shelf, slope, and in offshore waters (IOC 2013).

Pantropical Spotted Dolphin (*Stenella attenuata*)

Pantropical spotted dolphins generally occur in deep offshore waters between 40°N and 40°S (Jefferson et al. 2008). Very few sightings were mapped by DoN (2008a,b) off Virginia and North Carolina: four in spring, one in winter, one in summer, and none in fall, although there were numerous sightings of unidentified spotted dolphins. Waring et al. (2010) reported one sighting off North Carolina and one off South Carolina during NEFSC and SEFSC surveys in the summer during 1998–2004. In addition, there are 91 OBIS sighting records for waters off Virginia and North Carolina, mostly in shelf waters, including the proposed survey area (IOC 2013).

Atlantic Spotted Dolphin (*Stenella frontalis*)

In the western Atlantic, the distribution of the Atlantic spotted dolphin extends from southern New England, south to the Gulf of Mexico, the Caribbean Sea, Venezuela, and Brazil (Leatherwood et al. 1976; Perrin et al. 1994a; Rice 1998). Numerous Atlantic spotted dolphin sightings off Virginia and North Carolina were mapped by DoN (2008a,b), especially in spring and summer, mainly near the shelf edge but also in shelf waters, on the slope, and offshore. Also mapped were numerous sightings of unidentified spotted dolphins. Numerous sightings were reported during summer NEFSC and SEFSC surveys between 1998 and 2011 on the shelf off North Carolina and seaward of the shelf break off Virginia and North Carolina (Waring et al. 2013). Palka (2012) also reported several sightings for offshore waters off Virginia during June–August 2011 surveys. There are 162 OBIS sighting records for the waters off Virginia and North Carolina, mostly in shelf waters, including the proposed survey area (IOC 2013).

Spinner dolphin (*Stenella longirostris*)

The spinner dolphin is pantropical in distribution, with a range nearly identical to that of the pantropical spotted dolphin, including oceanic tropical and sub-tropical waters between 40ºN and 40ºS (Jefferson et al. 2008). The distribution of spinner dolphins in the Atlantic is poorly known, but they are thought to occur in deep waters along most of the U.S. coast; sightings off the northeast U.S. coast have occurred exclusively in offshore waters >2000 m (Waring et al. 2010). Five sightings off Virginia and North Carolina were mapped by DoN (2008a,b), all just outside the shelf break in winter, spring, and summer; there were also sightings of unidentified *Stenella* in all seasons, near the shelf break, on the slope, and in offshore waters. There are two OBIS sighting records of spinner dolphins (IOC 2013): one at the shelf break off North Carolina and one in deep, offshore waters off Virginia, made during CETAP surveys (CETAP 1982). Spinner dolphins likely would not be encountered during the proposed survey.

Striped Dolphin (*Stenella coeruleoalba*)

In the western North Atlantic, the striped dolphin occurs from Nova Scotia to the Gulf of Mexico and south to Brazil (Würsig et al. 2000). Off the northeastern U.S. coast, striped dolphins occur along the continental shelf edge and over the continental slope from Cape Hatteras to the southern edge of Georges Bank (Waring et al. 2013). In all seasons, striped dolphin sightings have been centered along the 1000-m depth contour, and sightings have been associated with the north edge of the Gulf Stream and warm core rings (Waring et al. 2013). Their occurrence off the northeastern U.S. coast seems to be highest in summer and lowest in fall (DoN 2005).

Off Virginia and North Carolina, striped dolphin sightings are made year-round, with the fewest number of sightings during fall (DoN 2008a,b). All were north of Cape Hatteras and almost all were in deep, offshore water. There are 126 OBIS sighting records of striped dolphins off Virginia and North

Carolina, at the shelf break and in deep, offshore water, including the proposed survey area (IOC 2013). Several sightings were also reported off the shelf break during summer NEFSC and SEFSC surveys between 1998 and 2011 (Waring et al. 2013). Palka (2012) also reported several sightings for offshore waters off Virginia during June–August 2011 surveys.

Clymene Dolphin (*Stenella clymene*)

The Clymene dolphin only occurs in tropical and subtropical waters of the Atlantic Ocean (Jefferson et al. 2008). In the western Atlantic, it occurs from New Jersey to Florida, the Caribbean Sea, the Gulf of Mexico, and south to Venezuela and Brazil (Würsig et al. 2000; Fertl et al. 2003). It is generally sighted in deep waters beyond the shelf edge (Fertl et al. 2003). There are a few sightings for waters off the coast of Virginia and North Carolina, including in fall, and almost all in deep, offshore water (Fertl et al. 2003; DoN 2008a,b). There are also six OBIS sighting records for shelf and deep waters off North Carolina (IOC 2013).

Short-beaked Common Dolphin (*Delphinus delphis*)

The short-beaked common dolphin occurs from Cape Hatteras to Georges Bank during mid January–May, moves onto Georges Bank and the Scotian Shelf during mid summer and fall, and has been observed in large aggregations on Georges Bank in fall (Selzer and Payne 1988; Waring et al. 2013). Sightings off Virginia and North Carolina were made during all seasons, with most sightings during winter and spring; in winter and spring, sightings were on the shelf, near the shelf break, and in offshore water, whereas in summer and fall, sightings were close to the shelf break (DoN 2008a,b). There are several hundred OBIS sighting records off the coasts of Virginia and North Carolina, including within the proposed survey area, with sightings on the shelf, near the shelf edge, and in offshore waters (IOC 2013).

Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)

The Atlantic white-sided dolphin occurs in cold temperate to subpolar waters of the North Atlantic in deep continental shelf and slope waters (Jefferson et al. 2008). Along the northeastern coast of the U.S., it ranges south to ~37ºN (CETAP 1982). There are seasonal shifts in its distribution off the northeastern U.S. coast, with low numbers in winter from Georges Basin to Jeffrey's Ledge and high numbers in spring in the Gulf of Maine (CETAP 1982; DoN 2005). In summer, Atlantic white-sided dolphins are mainly distributed northward from south of Cape Cod (DoN 2005). Sightings south of ~40ºN are infrequent during all seasons (CETAP 1982; DoN 2005). DoN (2008a) mapped 10 sightings off Virginia and North Carolina in all seasons, with most (4) in winter and fewest (1) in fall. During the CETAP surveys, two sightings were made during summer off Virginia, but no sightings were made off North Carolina (CETAP 1982). There is one OBIS sighting record in shelf waters off North Carolina and nine for Virginia just north of the proposed survey area, in shelf and deep, offshore waters (IOC 2013). White-sided dolphins likely would not be encountered during the proposed survey.

Fraser's Dolphin (*Lagenodelphis hosei*)

Fraser's dolphin is a tropical species distributed between 30ºN and 30ºS (Dolar 2009). It only rarely occurs in temperate regions, and then only in relation to temporary oceanographic anomalies such as El Niño events (Perrin et al. 1994b). The distribution of this species in the Atlantic is poorly known, but it is believed to be most abundant in the deep waters of the Gulf of Mexico (Dolar 2009). The only sighting during NMFS surveys was one off-transect sighting of an estimated 250 Fraser's dolphins in 1999 off Cape Hatteras, in waters 3300 m deep (NMFS 1999 *in* Waring et al. 2010); this sighting occurred within the proposed survey area. Fraser's dolphins likely would not be encountered during the proposed survey.

Risso's Dolphin (*Grampus griseus*)

The highest densities of Risso's dolphin occur in mid latitudes ranging from 30° to 45°, and primarily in outer continental shelf and slope waters (Jefferson et al. 2013). According to Payne et al. (1984 *in* Waring et al. 2013), Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras to Georges Bank during spring, summer, and autumn, but they range in the North Atlantic Bight and into oceanic waters during winter (Waring et al. 2013). Mapping of Risso's dolphin sightings off the U.S. east coast suggests that they could occur year-round from the Scotian Shelf to the coast of the southeastern U.S. in waters extending from the continental shelf to the continental rise (DoN 2005). DoN (2008a,b) mapped numerous sightings throughout the year off the coasts of Virginia and North Carolina, most in spring, and almost all on the shelf break or in deeper water. Palka (2012) also made several sightings of Risso's dolphins in deep, offshore waters off Virginia. Several sightings were also reported during summer NEFSC and SEFSC surveys between 1998 and 2011 for the shelf break off Virginia and North Carolina (Waring et al. 2013). There are 199 OBIS records off the coasts of Virginia and North Carolina, including shelf and shelf break, and offshore waters within the proposed survey (IOC 2013).

Melon-headed Whale (*Peponocephala electra*)

The melon-headed whale is a pantropical species usually occurring between 40ºN and 35ºS (Jefferson et al. 2008). Occasional occurrences in temperate waters are extralimital, likely associated with warm currents (Perryman et al. 1994; Jefferson et al. 2008). Melon-headed whales are oceanic and occur in offshore areas (Perryman et al. 1994), as well as around oceanic islands. Off the east coast of the U.S., sightings have been of two groups (20 and 80) of melon-headed whales off Cape Hatteras in waters >2500 m deep during vessel surveys in 1999 and 2002 (NMFS 1999, 2002 *in* Waring et al. 2010). Melon-headed whales likely would not be encountered during the proposed survey.

Pygmy Killer Whale (*Feresa attenuata*)

The pygmy killer whale is pantropical/subtropical, generally occurring between 40ºN and 35ºS (Jefferson et al. 2008). There is no abundance estimate for the pygmy killer whale off the U.S. east coast because it is rarely sighted during surveys (Waring et al. 2010). One group of six pygmy killer whales was sighted off Cape Hatteras in waters >1500 m deep during a NMFS vessel survey in 1992 (Hansen et al. 1994 *in* Waring et al. 2010). There are also two OBIS sighting records off Virginia, in deep, offshore water (Palka et al. 1991 *in* IOC 2013). DoN (2008a,b) mapped one sighting in deep water off North Carolina in winter, one stranding in spring, and one stranding in fall. Pygmy killer whales likely would not be encountered during the proposed survey.

False Killer Whale (*Pseudorca crassidens*)

The false killer whale is found worldwide in tropical and temperate waters generally between 50ºN and 50ºS (Odell and McClune 1999). It is widely distributed, but not abundant anywhere (Carwardine 1995). In the western Atlantic, it occurs from Maryland to Argentina (Rice 1998). Very few false killer whales were sighted off the U.S. northeast coast in the numerous surveys mapped by DON (2005, 2008a,b): off Virginia and North Carolina, two sightings were made during summer and one during spring (DoN 2008a,b). There are five OBIS sighting records for the waters off Virginia and North Carolina, on the shelf, along the shelf edge, and in deep water (IOC 2013), including one sighting during the 1978–1982 CETAP surveys (CETAP 1982). False killer whales likely would not be encountered during the proposed survey.

Killer Whale (*Orcinus orca*)

In the western North Atlantic, the killer whale occurs from the polar ice pack to Florida and the Gulf of Mexico (Würsig et al. 2000). Based on historical sightings and whaling records, killer whales apparently were most often found along the shelf break and offshore in the northwest Atlantic (Katona et al. 1988). They are considered uncommon or rare in waters of the U.S. Atlantic EEZ (Katona et al. 1988). Killer whales represented <0.1 % of all cetacean sightings (12 of 11,156 sightings) in CETAP surveys during 1978–1981 (CETAP 1982). Four of the 12 sightings made during the CETAP surveys were made offshore from North Carolina. DoN (2008a,b) mapped eight sightings off Virginia and North Carolina, all during spring and almost all along the shelf break and in deep, offshore water. There are 39 OBIS sighting records for the waters off the eastern U.S., four of which were off North Carolina, on the shelf, along the shelf edge, and in deep water (IOC 2013). Killer whales likely would not be encountered during the proposed survey.

Long- and Short-finned Pilot Whales (*Globicephala melas* and *G. macrorhynchus*)

There are two species of pilot whale, both of which could occur in the survey area. The long-finned pilot whale (*G. melas*) is distributed antitropically, whereas the short-finned pilot whale (*G. macrorhynchus*) is found in tropical, subtropical, and warm temperate waters (Olson 2009). In the northwest Atlantic, pilot whales often occupy areas of high relief or submerged banks and associated with the Gulf Stream edge or thermal fronts along the continental shelf edge (Waring et al. 1992). The ranges of the two species overlap in the shelf/shelf-edge and slope waters of the northeastern U.S. between New Jersey and Cape Hatteras, with long-finned pilot whales occurring to the north (Bernard and Reilly 1999).

Pilot whales are common off North Carolina and Virginia year-round, and almost all were along the shelf break or in deeper water (DoN 2008a,b). There are several hundred OBIS sighting records for pilot whales for shelf, slope, and offshore waters off Virginia and North Carolina, including within the proposed survey area; these sightings include *G. macrorhynchus* and *G. melas* (IOC 2013). Numerous sightings were also reported during summer NEFSC and SEFSC surveys between 1998 and 2007 for the shelf break off North Carolina and Virginia (Waring et al. 2010). Palka (2012) reported two sightings of short-finned pilot whales and two sightings of *Globicephala* spp. off Virginia during June–August 2011 surveys.

Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise inhabits cool temperate to subarctic waters of the Northern Hemisphere (Jefferson et al. 2008). There are likely four populations in the western North Atlantic: Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, Newfoundland, and Greenland (Gaskin 1984, 1992). Individuals found off the eastern U.S. coast likely would be almost exclusively from the Gulf of Maine/Bay of Fundy stock.

Harbor porpoises concentrate in the northern Gulf of Maine and southern Bay of Fundy during July–September, with a few sightings ranging as far south as Georges Bank and one sighting off Virginia (Waring et al. 2013). In summer, sightings mapped from numerous sources generally extended only as far south as Long Island, New York (DoN 2005). During October–December and April–June, harbor porpoises are dispersed and range from New Jersey to Maine, although there are lower densities at the northern and southern extremes (DoN 2005; Waring et al. 2013). Most animals are found over the continental shelf, but some are also encountered over deep water (Westgate et al. 1998). During January–March, harbor porpoises concentrate farther south, from New Jersey to North Carolina, with lower densities occurring from New York to New Brunswick (DoN 2005; Waring et al. 2013).

There are five OBIS sighting records for shelf waters off Virginia and North Carolina, and hundreds of stranding records (IOC 2013). Also for the waters off Virginia and North Carolina, DoN (2008a,b) mapped 7 sighting records and 10 bycatch records in winter, 1 sighting and 1 bycatch record in spring, and 1 sighting in fall. There were also numerous stranding records in winter and spring, and one in fall (DoN 2008a,b). Harbor porpoises likely would not be encountered during the proposed survey.

V. Type of Incidental Take Authorization Requested

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death), and the method of incidental taking.

L-DEO requests an IHA pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA) for incidental take by harassment during its planned seismic survey in the Atlantic Ocean off Cape Hatteras during September–October 2014.

The operations outlined in § I have the potential to take marine mammals by harassment. Sounds will be generated by the airguns used during the survey, by echosounders, and by general vessel operations. “Takes” by harassment will potentially result when marine mammals near the activities are exposed to the pulsed sounds generated by the airguns or echosounders. The effects will depend on the species of marine mammal, the behavior of the animal at the time of reception of the stimulus, as well as the distance and received level of the sound (see § VII). Disturbance reactions are likely amongst some of the marine mammals near the tracklines of the source vessel. No take by serious injury is anticipated, given the nature of the planned operations and the mitigation measures that are planned (see § XI, Mitigation Measures). No lethal takes are expected.

VI. Numbers of Marine Mammals That Could be Taken

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in [section V], and the number of times such takings by each type of taking are likely to occur.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

VII. Anticipated Impact on Species or Stocks

The anticipated impact of the activity upon the species or stock of marine mammal.

The material for § VI and § VII has been combined and presented in reverse order to minimize duplication between sections.

- First we summarize the potential impacts on marine mammals of airgun operations, as called for in § VII. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.

- Then we summarize the potential impacts of operations by the echosounders. A more comprehensive review of the relevant background information appears in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS.
- Finally, we estimate the numbers of marine mammals that could be affected by the proposed survey in the Atlantic Ocean off Cape Hatteras during September–October 2014. This section includes a description of the rationale for the estimates of the potential numbers of harassment "takes" during the planned survey, as called for in § VI. Acoustic modeling was conducted by L-DEO, determined to be acceptable by NMFS to use in the calculation of estimated takes under the MMPA (e.g., NMFS 2013a,b).

Summary of Potential Effects of Airgun Sounds

The effects of sounds from airguns could include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007). Permanent hearing impairment (PTS), in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not an injury (Southall et al. 2007). Although the possibility cannot be entirely excluded, it is unlikely that the project would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. If marine mammals encounter the survey while it is underway, some behavioral disturbance could result, but this would be localized and short-term.

Tolerance

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Several studies have shown that marine mammals at distances more than a few kilometers from operating seismic vessels often show no apparent response. That is often true even in cases when the pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales and toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to airgun pulses under some conditions, at other times mammals of all three types have shown no overt reactions. The relative responsiveness of baleen and toothed whales are quite variable.

Masking

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data on this. Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (e.g., Simard et al. 2005; Clark and Gagnon 2006), which could mask calls. Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls usually can be heard between the seismic pulses. The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking. In general, masking effects of seismic pulses are expected to be minor, given the normally intermittent nature of seismic pulses.

Disturbance Reactions

Disturbance includes a variety of effects, including subtle to conspicuous changes in behavior, movement, and displacement. Based on NMFS (2001, p. 9293), NRC (2005), and Southall et al. (2007), we believe that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially significant manner, do not constitute harassment or “taking”. By potentially significant, we mean, ‘in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations’.

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson et al. 1995; Wartzok et al. 2004; Southall et al. 2007; Weilgart 2007). If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (e.g., Lusseau and Bejder 2007; Weilgart 2007). Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many marine mammals would be present within a particular distance of industrial activities and/or exposed to a particular level of industrial sound. In most cases, this approach likely overestimates the numbers of marine mammals that would be affected in some biologically important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically important degree by a seismic program are based primarily on behavioral observations of a few species. Detailed studies have been done on humpback, gray, bowhead, and sperm whales. Less detailed data are available for some other species of baleen whales and small toothed whales, but for many species, there are no data on responses to marine seismic surveys.

Baleen Whales.—Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the cases of migrating gray and bowhead whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors.

Responses of *humpback whales* to seismic surveys have been studied during migration, on summer feeding grounds, and on Angolan winter breeding grounds; there has also been discussion of effects on the Brazilian wintering grounds. Off Western Australia, avoidance reactions began at 5–8 km from the array, and that those reactions kept most pods ~3–4 km from the operating seismic boat; there was localized displacement during migration of 4–5 km by traveling pods and 7–12 km by more sensitive resting pods of cow-calf pairs. However, some individual humpback whales, especially males, approached within distances of 100–400 m.

In the Northwest Atlantic, sighting rates were significantly greater during non-seismic periods compared with periods when a full array was operating, and humpback whales were more likely to swim away and less likely to swim towards a vessel during seismic vs. non-seismic periods. On their summer feeding grounds in southeast Alaska, there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 re 1 μPa on an approximate rms basis. It has been suggested that South Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys, but data from subsequent years, indicated that there was no observable direct correlation between strandings and seismic surveys.

There are no data on reactions of *right whales* to seismic surveys, but results from the closely related *bowhead whale* show that their responsiveness can be quite variable depending on their activity (migrating vs. feeding). Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with substantial avoidance occurring out to distances of 20–30 km from a medium-sized airgun source. However, more recent research on bowhead whales corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources.

Reactions of migrating and feeding (but not wintering) *gray whales* to seismic surveys have been studied. Off St. Lawrence Island in the northern Bering Sea, it was estimated, based on small sample sizes, that 50% of feeding gray whales stopped feeding at an average received pressure level of 173 dB re 1 μPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB re 1 μPa_{rms}. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast, and western Pacific gray whales feeding off Sakhalin Island, Russia.

Various species of *Balaenoptera* (blue, sei, fin, and minke whales) have occasionally been seen in areas ensonified by airgun pulses; sightings by observers on seismic vessels off the United Kingdom from 1997 to 2000 suggest that, during times of good sightability, sighting rates for mysticetes (mainly fin and sei whales) were similar when large arrays of airguns were shooting vs. silent, although there was localized avoidance. Singing fin whales in the Mediterranean moved away from an operating airgun array.

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America with substantial increases in the population over recent years, despite intermittent seismic exploration (and much ship traffic) in that area for decades. The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a previous year, and bowhead whales have continued to travel to the eastern Beaufort Sea each summer, and their numbers have increased notably, despite seismic exploration in their summer and autumn range for many years.

Toothed Whales.—Little systematic information is available about reactions of toothed whales to sound pulses. However, there are recent systematic studies on sperm whales, and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies. Seismic operators and marine mammal observers on seismic vessels regularly see dolphins and other small toothed whales near operating airgun arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels. In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 km or less, and some individuals show no apparent avoidance. The beluga, however, is a species that (at least at times) shows long-distance (10s of km) avoidance of seismic vessels. Captive bottlenose dolphins and beluga whales exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys, but the animals tolerated high received levels of sound before exhibiting aversive behaviors.

Most studies of *sperm whales* exposed to airgun sounds indicate that the sperm whale shows considerable tolerance of airgun pulses; in most cases the whales do not show strong avoidance, and they continue to call, but foraging behavior can be altered upon exposure to airgun sound. There are almost no specific data on the behavioral reactions of *beaked whales* to seismic surveys. However, some northern bottlenose whales remained in the general area and continued to produce high-frequency clicks when exposed to sound pulses from distant seismic surveys. Most beaked whales tend to avoid approaching vessels of other types, and may also dive for an extended period when approached by a vessel. In any event, it is likely that most beaked whales would also show strong avoidance of an approaching seismic vessel, although this has not been documented explicitly.

Odontocete reactions to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for the more responsive of the mysticetes and some other odontocetes. A ≥170 dB disturbance criterion (rather than ≥160 dB) is considered appropriate for delphinids, which tend to be less responsive than the more responsive cetaceans.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. TTS has been demonstrated and studied in certain captive odontocetes and pinnipeds exposed to strong sounds. However, there has been no specific documentation of TTS let alone permanent hearing damage, i.e., PTS, in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions. Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds with received levels ≥180 dB and 190 dB re 1 μPa_{rms}, respectively (NMFS 2000). These criteria have been used in establishing the exclusion (=shut-down) zones planned for the proposed seismic survey. However, those criteria were established before there was any information about minimum received levels of sounds necessary to cause auditory impairment in marine mammals.

Recommendations for science-based noise exposure criteria for marine mammals, frequency-weighting procedures, and related matters were published by Southall et al. (2007). Those recommendations were never formally adopted by NMFS for use in regulatory processes and during mitigation programs associated with seismic surveys, although some aspects of the recommendations have been taken into account in certain environmental impact statements and small-take authorizations. In December 2013, NOAA made available for public comment new draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013a), taking at least some of the Southall et al. recommendations into account. At the time of preparation of this Draft EA, the date of release of the final guidelines and how they would be implemented are unknown.

Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airgun array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment (see § XI and § XIII). Also, many marine mammals and (to a limited degree) sea turtles show some avoidance of the area where received levels of airgun sound are high enough such that hearing impairment could potentially occur. In those cases, the avoidance responses of the animals themselves would reduce or (most likely) avoid any possibility of hearing impairment.

Non-auditory physical effects may also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong transient sounds. However, there is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, are especially unlikely to incur non-auditory physical effects. The brief duration of exposure of any given mammal, the deep water in the study area, and the planned monitoring and mitigation measures would further reduce the probability of exposure of marine mammals to sounds strong enough to induce non-auditory physical effects.

Possible Effects of Other Acoustic Sources

The Kongsberg EM 122 MBES, Knudsen Chirp 3260 SBP, and Teledyne OS75 75-kHz ADCP would be operated from the source vessel during the proposed survey. The PEIS concluded in § 3.6.4.3 and § 3.7.4.3 that operation of multibeam echosounders (MBES), sub-bottom profilers (SBP), and pingers is not likely to impact mysticetes or odontocetes because the intermittent and narrow, downward-directed nature of the acoustic sources would result in no more than one or two brief ping exposures of any individual animal, given the movement and speed of the vessel.

Numbers of Marine Mammals that could be "Taken by Harassment"

All anticipated takes would be "takes by harassment", involving temporary changes in behavior. The mitigation measures to be applied will minimize the possibility of injurious takes. (However, as noted earlier, there is no specific information demonstrating that injurious "takes" would occur even in the absence of the planned mitigation measures.) In the sections below, we describe methods to estimate the number of potential exposures to various received sound levels and present estimates of the numbers of marine mammals that could be affected during the proposed seismic program. The estimates are based on a consideration of the number of marine mammals that could be disturbed appreciably by operations with the 36- or 18-airgun array to be used during ~6350 km of seismic surveys in the Atlantic Ocean off Cape Hatteras. The sources of distributional and numerical data used in deriving the estimates are described in the next subsection.

It is assumed that, during simultaneous operations of the airgun array and the other sources, any marine mammals close enough to be affected by the MBES, SBP, and ADCP would already be affected by the airguns. However, whether or not the airguns are operating simultaneously with the other sources, marine mammals are expected to exhibit no more than short-term and inconsequential responses to the MBES, SBP, and ADCP, given their characteristics (e.g., narrow downward-directed beam) and other considerations described in § 3.6.4.3, § 3.7.4.3, and Appendix E of the PEIS. Such reactions are not considered to constitute "taking" (NMFS 2001). Therefore, no additional allowance is included for animals that could be affected by sound sources other than airguns.

Basis for Estimating "Take by Harassment"

The estimates are based on a consideration of the number of marine mammals that could be within the area around the operating airgun array where the received levels (RLs) of sound >160 dB re 1 μPa_{rms} are predicted to occur (see Table 1). The estimated numbers are based on the densities (numbers per unit area) of marine mammals expected to occur in the area in the absence of a seismic survey. To the extent that marine mammals tend to move away from seismic sources before the sound level reaches the criterion level and tend not to approach an operating airgun array, these estimates are likely to overestimate the numbers actually exposed to the specified level of sounds. The overestimation is expected to be particularly large when dealing with the higher sound-level criteria, e.g., 180 dB re 1 μPa_{rms}, as animals are more likely to move away before RL reaches 180 dB than they are to move away before it reaches (for example) 160 dB re 1 μPa_{rms}. Likewise, they are less likely to approach within the ≥180 dB re 1 μPa_{rms} radius than they are to approach within the considerably larger ≥160 dB radius.

We used densities calculated from the U.S. Navy's "OPAREA Density Estimates" (NODE) database (DoN 2007). The cetacean density estimates are based on the NMFS-SEFSC and NMFS-NEFSC vessel-based and aerial surveys conducted between 1998 and 2005; most (seven) surveys that included the proposed survey area were conducted in summer (between June and August), one vessel-based survey extended to the end of September, and one vessel-based and two aerial surveys were conducted in winter–spring (between January and April). Density estimates were derived using density surface modelling of the existing line-transect data, which uses sea surface temperature, chlorophyll *a*, depth, longitude, and latitude to allow extrapolation to areas/seasons where survey data were not collected. For some species, there were not enough sightings to be able to produce a density surface, so densities were estimated using traditional line-transect analysis. The models and analyses have been incorporated into a web-based Geographic Information System (GIS) developed by Duke University's Department of Defense Strategic Environmental Research and Development Program (SERDP) team in close collaboration with the NMFS SERDP team (Read et al. 2009). We used the GIS to obtain densities in polygons for the survey area separated into three depth strata (<100 m, 100–1000 m, and >1000 m) for the 20 cetacean species in the model. The GIS provides minimum, mean, and maximum estimates for four seasons, and we used the mean estimates for fall. Mean densities were used because the minimum and maximum estimates are for points within the polygons, whereas the mean estimate is for the entire polygons.

The estimated numbers of individuals potentially exposed presented below are based on the 160-dB re 1 μPa_{rms} criterion for all cetaceans. It is assumed that marine mammals exposed to airgun sounds that strong could change their behavior sufficiently to be considered "taken by harassment". The density estimates calculated as described above are shown in Table 3 with the estimates of the number of different individual marine mammals that potentially could be exposed to ≥160 dB re 1 μPa_{rms} during the seismic survey if no animals moved away from the survey vessel. The *Requested Take Authorization* is given in the far right column of Table 3.

It should be noted that the following estimates of exposures to various sound levels assume that the proposed survey would be completed; in fact, the ensonified areas calculated using the planned number of line-kilometers ***have been increased by 25%*** to accommodate turns, lines that may need to be repeated, equipment testing, etc. As is typical during offshore ship surveys, inclement weather and equipment malfunctions are likely to cause delays and may limit the number of useful line-kilometers of seismic operations that can be undertaken. Also, any marine mammal sightings within or near the designated exclusion zones would result in the shut down of seismic operations as a mitigation measure. Thus, the following estimates of the numbers of marine mammals potentially exposed to 160-dB re 1 μPa_{rms} sounds are precautionary and probably overestimate the actual numbers of marine mammals that could be involved. These estimates assume that there would be no weather, equipment, or mitigation delays, which is highly unlikely.

Consideration should be given to the hypothesis that delphinids are less responsive to airgun sounds than are mysticetes, as referenced in both the PEIS and "Summary of Potential Airgun Effects" of this document. The 160-dB (rms) criterion currently applied by NMFS, on which the following estimates are based, was developed based primarily on data from gray and bowhead whales. The estimates of "takes by harassment" of delphinids given below are thus considered precautionary. In December 2013, NOAA made available for public comment new draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013a), although at the time of preparation of this Draft EA, the date of release of the final guidelines and how they would be implemented are unknown. Available data suggest that the current use of a 160-dB criterion may be improved upon, as behavioral response may not occur for some percentage of odontocetes and mysticetes exposed to received levels >160 dB, whereas other individuals or groups may respond in a manner considered as taken to sound levels <160 dB (NMFS 2013c). It has become evident that the context of an exposure of a marine mammal to sound can affect the animal's initial response to the sound (NMFS 2013c).

Potential Number of Marine Mammals Exposed

The number of different individuals that could be exposed to airgun sounds with received levels ≥160 dB re 1 μPa_{rms} on one or more occasions can be estimated by considering the total marine area that would be within the 160-dB radius around the operating seismic source on at least one occasion, along with the expected density of animals in the area. The number of possible exposures (including repeated exposures of the same individuals) can be estimated by considering the total marine area that would be within the 160-dB radius around the operating airguns, including areas of overlap. During the proposed survey, the transect lines are widely spaced relative to the 160-dB distance. Thus, the area including overlap is 1.79 times the area excluding overlap, so a marine mammal that stayed in the survey area during the entire survey could be exposed slightly less than twice, on average. However, it is unlikely that a particular animal would stay in the area during the entire survey. The numbers of different individuals potentially exposed to ≥160 dB re 1 μPa_{rms} were calculated by multiplying the expected species density times the anticipated area to be ensonified to that level during airgun operations excluding overlap. The area expected to be ensonified was determined by entering the planned survey lines into a MapInfo GIS, using the GIS to identify the relevant areas by "drawing" the applicable 160-dB buffer (see Table 1) around each seismic line, and then calculating the total area within the buffers.

TABLE 3. Densities and estimates of the possible numbers of individuals that could be exposed to >160 dB re 1 μPa$_{rms}$ during L-DEO's proposed seismic survey in the Atlantic Ocean off Cape Hatteras during September–October 2014. The proposed sound source consists of a 36-airgun array with a total discharge volume of ~6600 in^3 or an 18-airgun array with a total discharge volume of ~3300 in^3. Species in italics are listed under the ESA as endangered. The column of numbers in boldface shows the numbers of Level B "takes" for which authorization is requested.

	Reported density[1] (#/1000 km^2) in depth range (m)			Ensonified area (1000 km^2) in depth range (m)			Calculated Take[2] in depth range (m)				% Regional pop'n[3]	Requested Level B Take Authorization
Species	<100	100-1000	>1000	<100	100-1000	>1000	<100	100-1000	>1000	All		
Mysticetes												
North Atlantic right whale	*0*	*0*	*0*	*15.17*	*6.65*	*42.90*	*0*	*0*	*0*	*0*	*0*	***0***
Humpback whale	*0.73*	*0.56*	*1.06*	*15.17*	*6.65*	*42.90*	*11*	*4*	*46*	*60*	*0.52*	***60***
Minke whale	0.03	0.02	0.04	*15.17*	*6.65*	*42.90*	0	0	2	2	0.01	**2**
Sei whale	*0*	*0*	*0*	*15.17*	*6.65*	*42.90*	*0*	*0*	*0*	*0*	*0*	***0***
Fin whale	*<0.01*	*0.01*	*0.01*	*15.17*	*6.65*	*42.90*	*0*	*0*	*0*	*0*	*<0.01*	***1***
Blue whale	*0*	*0*	*0*	*15.17*	*6.65*	*42.90*	*0*	*0*	*0*	*0*	*0*	***1***
Odontocetes												
Sperm whale	*0.03*	*0.68*	*3.23*	*15.17*	*6.65*	*42.90*	*1*	*4*	*139*	*144*	*1.09*	***144***
Pygmy/dwarf sperm whale	0.64	0.49	0.93	*15.17*	*6.65*	*42.90*	10	3	40	53	1.39	**53**
Beaked whales[4]	0.01	0.14	0.58	*15.17*	*6.65*	*42.90*	0	1	25	26	0.19	**26**
Rough-toothed dolphin	0.30	0.23	0.44	*15.17*	*6.65*	*42.90*	5	2	19	25	9.23	**25**
Bottlenose dolphin	70.4	331.0	49.4	*15.17*	*6.65*	*42.90*	1068	2200	2120	5388	6.21	**5388**
Pantropical spotted dolphin	14.0	10.7	20.4	*15.17*	*6.65*	*42.90*	213	71	874	1158	34.74	**1158**
Atlantic spotted dolphin	216.5	99.7	77.4	*15.17*	*6.65*	*42.90*	3285	663	3322	7270	16.26	**7270**
Spinner dolphin[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Striped dolphin	0	0.4	3.53	*15.17*	*6.65*	*42.90*	0	2	151	154	0.28	**154**
Clymene dolphin	6.70	5.12	9.73	*15.17*	*6.65*	*42.90*	102	34	418	553	N/A	**553**
Common dolphin	5.8	138.7	26.4	*15.17*	*6.65*	*42.90*	88	922	1132	2142	1.23	**2142**
Atlantic white-sided dolphin	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Fraser's dolphin[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Risso's dolphin	1.18	4.28	2.15	*15.17*	*6.65*	*42.90*	18	28	92	139	0.76	**139**
Melon-headed whale[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Pygmy killer whale[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
False killer whale[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Killer whale[5]	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**
Pilot whale	3.74	58.9	19.1	*15.17*	*6.65*	*42.90*	57	392	820	1268	0.16	**1268**
Harbor porpoise	0	0	0	*15.17*	*6.65*	*42.90*	0	0	0	0	0	**0**

[1] Densities are the mean values for the depth stratum in the survey area, calculated from the SERDP model of Read et al. (2009)

[2] Calculated take is reported density multiplied by the 160-dB ensonified area (including the 25% contingency); calculated take for the fin whale was 0.49 so requested take is 1.

[3] Requested takes expressed as percentages of the larger regional populations, where available, for species that are at least partly pelagic; where not available (most odontocetes–see Table 3), SAR population estimates were used. This results in overestimates, particularly for the pantropical and Atlantic spotted dolphins, as SAR estimates are based on surveys only in U.S. waters rather than in their full ranges. N/A means not available

[4] May include Cuvier's, True's, Gervais', or Blainville's beaked whales

Applying the approach described above, ~51,775 km^2 (~64,720 km^2 including the 25% contingency) would be within the 160-dB isopleth on one or more occasions during the proposed survey. Because this approach does not allow for turnover in the mammal populations in the area during the course of the survey, the actual number of individuals exposed may be underestimated, although the conservative (i.e., probably overestimated) line-kilometer distances used to calculate the area may offset this. Also, the approach assumes that no cetaceans would move away or toward the trackline as the *Langseth* approaches in response to increasing sound levels before the levels reach 160 dB. Another way of interpreting the estimates that follow is that they represent the number of individuals that are expected (in the absence of a seismic program) to occur in the waters that would be exposed to ≥160 dB re 1 μPa$_{rms}$.

The estimate of the number of individual cetaceans that could be exposed to seismic sounds with received levels ≥160 dB re 1 μPa$_{rms}$ during the proposed survey is 18,382 (Table 7). That total includes 204 cetaceans listed as ***Endangered*** under the ESA, including 60 humpback whales (0.52% of the regional population) and 144 sperm whales (1.09%). It also includes 26 beaked whales (0.19%), probably mostly Cuvier's whale. Most (98.5%) of the cetaceans potentially exposed are delphinids; the Atlantic spotted dolphin, bottlenose dolphin, short-beaked common dolphin, short- and long-finned pilot whales, and pantropical spotted dolphin are estimated to be the most common delphinid species in the area, with estimates of 7270 (16.26% of the regional population), 5388 (6.21%), 2142 (1.23%), 1268 (0.16%), and 1158 (34.74%) exposed to ≥160 dB re 1 μPa_{rms}, respectively. All percentage estimates for delphinids except for the pilot whales are very likely overestimates, in some cases considerable overestimates, because the population sizes are very likely underestimates. This is because there are no truly regional population size estimates (e.g., for the northwest Atlantic) for most delphinids, most of which are at least partly pelagic; rather, the population sizes are based on surveys in U.S. waters, which represent only a small fraction of northwest Atlantic waters.

Conclusions

The proposed seismic project would involve towing a 36-airgun array with a total discharge volume of 6600 in^3 or an 18-airgun array with a total discharge volume of 3300 in^3 that introduces pulsed sounds into the ocean. Routine vessel operations, other than the proposed seismic operations, are conventionally assumed not to affect marine mammals sufficiently to constitute "taking".

Cetaceans.— In § 3.6.7 and 3.7.7, the PEIS concluded that airgun operations with implementation of the proposed monitoring and mitigation measures could result in a small number of Level B behavioral effects in some mysticete and odontocete species, and that Level A effects were highly unlikely.

In this IHA Application, estimates of the numbers of marine mammals that could be exposed to airgun sounds during the proposed program have been presented, together with the requested "take authorization". For most species predicted to be exposed to sound levels sufficient to cause appreciable disturbance, including all ESA listed species, the estimated numbers of animals potentially exposed are low percentages of the regional population sizes (Table 3). For some delphinid species, the estimated numbers potentially exposed are higher percentages of the populations in the NMFS SARs; as discussed above, we believe that those percentages are overestimates because the "regional" population sizes—in fact, the estimated population sizes in U.S. waters—underestimate true regional population sizes, in some cases considerably. The estimates of exposures are also likely overestimates of the actual number of animals that would be exposed to and would react to the seismic sounds. The reasons for that conclusion are outlined above. The relatively short-term exposures are unlikely to result in any long-term negative consequences for the individuals or their populations. Therefore, no significant impacts on cetaceans would be anticipated from the proposed activities.

VIII. Anticipated Impact on Subsistence

The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses.

There is no subsistence hunting near the proposed survey area, so the proposed activities will not have any impact on the availability of the species or stocks for subsistence users.

IX. Anticipated Impact on Habitat

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

The proposed seismic survey would not result in any permanent impact on habitats used by marine mammals or to the food sources they use. The main impact issue associated with the proposed activity will be temporarily elevated noise levels and the associated direct effects on marine mammals, as discussed in § VII, above. This section briefly reviews the conclusions of the PEIS about effects of airguns on fish and invertebrates.

Effects of seismic sound on marine invertebrates (crustaceans and cephalopods), marine fish, and their fisheries are discussed in § 3.2.4 and § 3.3.4 and Appendix D of the PEIS. The PEIS concluded that there could be changes in behavior and other non-lethal, short-term, temporary impacts, and injurious or mortal impacts on a small number of individuals within a few meters of a high-energy acoustic source, but that there would be no significant impacts of NSF-funded marine seismic research on populations.

X. Anticipated Impact of Loss or Modification of Habitat on Marine Mammals

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed activity is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, because operations will be limited in duration. However, a small minority of the marine mammals that are present near the proposed activity may be temporarily displaced as much as a few kilometers by the planned activity.

XI. Mitigation Measures

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Marine mammals and sea turtles are known to occur in the proposed study area. To minimize the likelihood that impacts will occur to the species and stocks, airgun operations will be conducted in accordance with the MMPA and the ESA, including obtaining permission for incidental harassment or incidental 'take' of marine mammals and other endangered species. The proposed activities will take place mostly in the U.S. EEZ with a small portion in International Waters.

The following subsections provide more detailed information about the mitigation measures that are an integral part of the planned activities. The procedures described here are based on protocols used during previous L-DEO seismic research cruises as approved by NMFS, and on best practices recommended in Richardson et al (1995), Pierson et al. (1998), and Weir and Dolman (2007).

Planning Phase

As discussed in § 2.4.1.1 of the PEIS, mitigation of potential impacts from the proposed activities begins during the planning phase of the proposed activities. Several factors were considered during the planning phase of the proposed activities, including

1. Energy Source— Part of the considerations for the proposed marine seismic survey was to evaluate whether the research objectives could be met with a smaller energy source than the full, 36-airgun, 6600-in^3 *Langseth* array, and it was decided that the scientific objectives for most of the survey could not be met using a smaller source because of the need to image the crust-mantle boundary at a depth of 30 km beneath the continental shelf and slope. For some lines of the survey, the target of interest is at a shallower depth, and it was decided that the 18-airgun, 3300-in^3 subarray towed at a shallowe depth (6 m vs. 9 m) would be adequate to image it.

2. Survey Timing—The PIs worked with L-DEO and NSF to identify potential time periods to carry out the survey taking into consideration key factors such as environmental conditions (i.e., the seasonal presence of marine mammals, sea turtles, and seabirds), weather conditions, equipment, and optimal timing for other proposed seismic surveys using the *Langseth*. Some marine mammal species are expected to occur in the area year-round, so altering the timing of the proposed project likely would result in no net benefits for those species. Some migratory species, such as the North Atlantic right whale, are expected to be farther north at the time of the survey, so the survey timing is beneficial for those species.
3. Mitigation Zones—During the planning phase, mitigation zones for the proposed survey were calculated based on modeling by L-DEO for both the exclusion zone (EZ) and the safety zone; these zones are given in Table 1. The proposed survey would acquire data with the 36-airgun array at a tow depth of 9 m, and the 18-airgun array at a tow depth of 6 m. For deep water (>1000 m), we use the deep-water radii obtained from L-DEO model results down to a maximum water depth of 2000 m. The radii for intermediate water depths (100–1000 m) are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve. For the 18-airgun array, the shallow-water radii are the empirically derived measurements from the GoM calibration survey. For the 36-airgun array, the shallow-water radii are obtained by scaling the empirically derived measurements from the GoM calibration survey to account for the difference in tow depth between the calibration survey (6 m) and the proposed survey (9 m). A more detailed description of the modeling process used to develop the mitigation zones can be found in § I.

   Table 1 shows the 180-dB EZ and 160-dB "Safety Zone" (distances at which the rms sound levels are expected to be received) for the mitigation airgun and the 18- and 36-airgun arrays. The 160 and 180-dB re 1 μPa_{rms} distances are the criteria currently specified by NMFS (2000) for cetaceans. Southall et al. (2007) made detailed recommendations for new science-based noise exposure criteria. In December 2013, NOAA published draft guidance for assessing the effects of anthropogenic sound on marine mammals (NOAA 2013a), although at the time of preparation of this Draft EA, the date of release of the final guidelines and how they will be implemented are unknown. As such, this Draft EA has been prepared in accordance with the current NOAA acoustic practices, and the procedures are based on best practices noted by Pierson et al. (1998) and Weir and Dolman (2007).

   The 180-dB distance would also be used as the EZ for sea turtles, as required by NMFS in most other recent seismic projects per the IHAs. Enforcement of mitigation zones via power and shut downs would be implemented in the Operational Phase, as noted below.

Mitigation During Operations

Mitigation measures that will be adopted during the proposed survey include (1) power-down procedures, (2) shut-down procedures, (3) ramp-up procedures, and (4) special procedures for situations or species of particular concern.

Power-down Procedures

A power down involves decreasing the number of airguns in use such that the radius of the 180-dB (or 190-dB) zone is decreased to the extent that marine mammals or turtles are no longer in or about to enter the EZ. During a power down, one airgun will be operated. The continued operation of one airgun is intended to alert marine mammals and turtles to the presence of the seismic vessel in the area. In contrast, a shut down occurs when all airgun activity is suspended.

If a marine mammal or turtle is detected outside the EZ but is likely to enter the EZ, the airguns will be powered down before the animal is within the EZ. Likewise, if a mammal or turtle is already within the EZ when first detected, the airguns will be powered down immediately. During a power down of the airgun array, the 40-in^3 airgun will be operated. If a marine mammal or turtle is detected within or near the smaller EZ around that single airgun (Table 1), it will be shut down (see next subsection).

Following a power down, airgun activity will not resume until the marine mammal or turtle has cleared the safety zone. The animal will be considered to have cleared the safety zone if

- it is visually observed to have left the EZ, or
- it has not been seen within the zone for 15 min in the case of small odontocetes, or
- it has not been seen within the zone for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales, or
- the vessel has moved outside the EZ for turtles, e.g., if a turtle is sighted close to the vessel and the ship speed is 8.3 km/h, it would take the vessel ~15 min to leave the turtle behind.

During airgun operations following a shut down whose duration has exceeded the time limits specified above, the airgun array will be ramped up gradually. Ramp-up procedures are described below. During past *Langseth* marine geophysical surveys, following an extended power-down period, the seismic source followed ramp-up procedures to return to the full seismic source level. Under a power-down scenario, however, a single mitigation airgun still would be operating to alert and warn animals of the on-going activity. Furthermore, under these circumstances, ramp-up procedures may unnecessarily extend the length of the survey time needed to collect seismic data. LDEO and NSF have concluded in consultation with NMFS that ramp up is not necessary after an extended power down. This assessment therefore does not include this practice as part of the monitoring and mitigation plan.

Shut-down Procedures

The operating airgun(s) will be shut down if a marine mammal or turtle is seen within or approaching the EZ for the single airgun. Shut downs will be implemented (1) if an animal enters the EZ of the single airgun after a power down has been initiated, or (2) if an animal is initially seen within the EZ of the single airgun when more than one airgun (typically the full array) is operating. Airgun activity will not resume until the marine mammal or turtle has cleared the safety zone, or until the PSO is confident that the animal has left the vicinity of the vessel. Criteria for judging that the animal has cleared the safety zone will be as described in the preceding subsection.

Ramp-up Procedures

A ramp-up procedure will be followed when the airgun array begins operating after a specified period without airgun operations. It is proposed that, for the present survey, this period would be ~8 min. Similar periods (~8–10 min) were used during previous L-DEO surveys. Ramp up will not occur if a marine mammal or sea turtle has not cleared the safety zone as described earlier.

Ramp up will begin with the smallest airgun in the array (40 in^3). Airguns will be added in a sequence such that the source level of the array will increase in steps not exceeding 6 dB per 5-min period. During ramp up, the PSOs will monitor the EZ, and if marine mammals or turtles are sighted, a power down or shut down will be implemented as though the full array were operational.

If the complete EZ has not been visible for at least 30 min prior to the start of operations in either daylight or nighttime, ramp up will not commence unless at least one airgun (40 in^3 or similar) has been operating during the interruption of seismic survey operations. Given these provisions, it is likely that the airgun array will not be ramped up from a complete shut down at night or in thick fog, because the outer part of the safety zone for that array will not be visible during those conditions. If one airgun has operated during a power-down period, ramp up to full power will be permissible at night or in poor visibility, on the assumption that marine mammals and turtles will be alerted to the approaching seismic vessel by the sounds from the single airgun and could move away. Ramp up of the airguns will not be initiated if a sea turtle or marine mammal is sighted within or near the applicable EZs during the day or night.

As noted above under "Power-down Procedures", during past R/V *Langseth* marine geophysical surveys, following an extended power-down period, the seismic source followed ramp-up procedures to return to the full seismic source level. Under a power-down scenario, however, a single mitigation airgun still would be operating to alert and warn animals of the on-going activity.

Special Procedures for Situations or Species of Concern

It is unlikely that a North Atlantic right whale would be encountered, but if so, the airguns will be shut down immediately if one is sighted at any distance from the vessel because of its rarity and conservation status. Also, it is unlikely that concentrations of humpback, fin, sperm, blue, or sei whales or dolphins would be encountered, but if so, they will be avoided.

XII. Plan of Cooperation

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;

(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;

(iii) A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

Not applicable. The proposed activity will take place in the Atlantic Ocean, and no activities will take place in or near a traditional Arctic subsistence hunting area.

XIII. Monitoring and Reporting Plan

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding...

L-DEO proposes to sponsor marine mammal monitoring during the present project, in order to implement the proposed mitigation measures that require real-time monitoring, and to satisfy the anticipated monitoring requirements of the IHA.

L-DEO's proposed Monitoring Plan is described below. L-DEO understands that this Monitoring Plan will be subject to review by NMFS, and that refinements may be required.

The monitoring work described here has been planned as a self-contained project independent of any other related monitoring projects that may be occurring simultaneously in the same regions. L-DEO is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical and desirable.

Vessel-based Visual Monitoring

Protected species observer (PSO) observations will take place during daytime airgun operations and nighttime start ups of the airguns. Airgun operations will be suspended when marine mammals or turtles are observed within, or about to enter, designated exclusion zones [see § XI above] where there is concern about potential effects on hearing or other physical effects. PSOs will also watch for marine mammals and turtles near the seismic vessel for at least 30 min prior to the planned start of airgun operations. Observations will also be made during daytime periods when the *Langseth* is underway without seismic operations, such as during transits.

During seismic operations, at least four visual PSOs will be based aboard the *Langseth*. PSOs will be appointed by L-DEO with NMFS concurrence. During the majority of seismic operations, two PSOs will monitor for marine mammals and sea turtles around the seismic vessel. Use of two simultaneous observers will increase the effectiveness of detecting animals around the source vessel. However, during meal times, only one PSO may be on duty. PSO(s) will be on duty in shifts of duration no longer than 4 h. Other crew will also be instructed to assist in detecting marine mammals and turtles and implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew will be given additional instruction regarding how to do so.

The *Langseth* is a suitable platform for marine mammal and turtle observations. When stationed on the observation platform, the eye level will be ~21.5 m above sea level, and the observer will have a good view around the entire vessel. During daytime, the PSO(s) will scan the area around the vessel systematically with reticle binoculars (e.g., 7×50 Fujinon), Big-eye binoculars (25×150), and with the naked eye. During darkness, night vision devices (NVDs) will be available (ITT F500 Series Generation 3 binocular-image intensifier or equivalent), when required. Laser rangefinding binoculars (Leica LRF 1200 laser rangefinder or equivalent) will be available to assist with distance estimation. Those are useful in training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly; that is done primarily with the reticles in the binoculars.

Passive Acoustic Monitoring

Passive acoustic monitoring (PAM) will take place to complement the visual monitoring program. Visual monitoring typically is not effective during periods of poor visibility or at night, and even with good visibility, is unable to detect marine mammals when they are below the surface or beyond visual range. Acoustical monitoring can be used in addition to visual observations to improve detection, identification, and localization of cetaceans. The acoustic monitoring will serve to alert visual observers (if on duty) when vocalizing cetaceans are detected. It is only useful when marine mammals call, but it can be effective either by day or by night, and does not depend on good visibility. It will be monitored in real time so that the visual observers can be advised when cetaceans are detected.

The PAM system consists of hardware (i.e., hydrophones) and software. The "wet end" of the system consists of a towed hydrophone array that is connected to the vessel by a tow cable. The tow cable is 250 m long, and the hydrophones are fitted in the last 10 m of cable. A depth gauge is attached to the free end of the cable, and the cable is typically towed at depths <20 m. The array will be deployed from a winch located on the back deck. A deck cable will connect the tow cable to the electronics unit in the main computer lab where the acoustic station, signal conditioning, and processing system will be located. The acoustic signals received by the hydrophones are amplified, digitized, and then processed by the Pamguard software. The system can detect marine mammal vocalizations at frequencies up to 250 kHz.

One acoustic PSO or PSAO (in addition to the 4 visual PSOs) will be on board. The towed hydrophones will ideally be monitored 24 h per day while at the seismic survey area during airgun operations, and during most periods when the *Langseth* is underway while the airguns are not operating. However, PAM may not be possible if damage occurs to the array or back-up systems during operations. One PSO will monitor the acoustic detection system at any one time, by listening to the signals from two channels via headphones and/or speakers and watching the real-time spectrographic display for frequency ranges produced by cetaceans. The PSAO monitoring the acoustical data will be on shift for 1–6 h at a time. All observers are expected to rotate through the PAM position, although the most experienced with acoustics will be on PAM duty more frequently.

When a vocalization is detected while visual observations are in progress, the PSAO will contact the visual PSO immediately, to alert him/her to the presence of cetaceans (if they have not already been seen), and to allow a power down or shut down to be initiated, if required. The information regarding the call will be entered into a database. The data to be entered include an acoustic encounter identification number, whether it was linked with a visual sighting, date, time when first and last heard and whenever any additional information was recorded, position and water depth when first detected, bearing if determinable, species or species group (e.g., unidentified dolphin, sperm whale), types and nature of sounds heard (e.g., clicks, continuous, sporadic, whistles, creaks, burst pulses, strength of signal, etc.), and any other notable information. The acoustic detection can also be recorded for further analysis.

PSO Data and Documentation

PSOs will record data to estimate the numbers of marine mammals and turtles exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data will be used to estimate numbers of animals potentially ‘taken’ by harassment (as defined in the MMPA). They will also provide information needed to order a power down or shut down of the airguns when a marine mammal or sea turtle is within or near the EZ.

When a sighting is made, the following information about the sighting will be recorded:

1. Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (e.g., none, avoidance, approach, paralleling, etc.), and behavioral pace.
2. Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare.

The data listed under (2) will also be recorded at the start and end of each observation watch, and during a watch whenever there is a change in one or more of the variables.

All observations and power downs or shut downs will be recorded in a standardized format. Data will be entered into an electronic database. The accuracy of the data entry will be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database. These procedures will allow initial summaries of data to be prepared during and shortly after the field program, and will facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

Results from the vessel-based observations will provide

1. The basis for real-time mitigation (airgun power down or shut down).
2. Information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS.
3. Data on the occurrence, distribution, and activities of marine mammals and turtles in the area where the seismic study is conducted.
4. Information to compare the distance and distribution of marine mammals and turtles relative to the source vessel at times with and without seismic activity.
5. Data on the behavior and movement patterns of marine mammals and turtles seen at times with and without seismic activity.

A report will be submitted to NMFS and NSF within 90 days after the end of the cruise. The report will describe the operations that were conducted and sightings of marine mammals and turtles near the operations. The report will provide full documentation of methods, results, and interpretation pertaining to all monitoring. The 90-day report will summarize the dates and locations of seismic operations, and all marine mammal and turtle sightings (dates, times, locations, activities, associated seismic survey activities). The report will also include estimates of the number and nature of exposures that could result in "takes" of marine mammals by harassment or in other ways.

XIV. Coordinating Research to Reduce and Evaluate Incidental Take

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

L-DEO and NSF would coordinate with applicable U.S. agencies (e.g., NMFS), and would comply with their requirements.

XV. Literature Cited

Aguilar, A. 1986. A review of old Basque whaling and its effect on the right whales of the North Atlantic. **Rep. Int. Whal. Comm. Spec. Iss**. 10:191-199.

Beaudin Ring, J. 2002. Right whale sightings and trackline data for the mid Atlantic by month, 1974–2002. Mid-Atlantic sightings archive. Accessed at http://www.nero.noaa.gov/shipstrike/doc/Historical%20sightings.htm on 3 September 2013.

Bernard, H.J. and S.B. Reilly. 1999. Pilot whales *Globicephala* Lesson, 1828. p. 245-279 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 6: The second book of dolphins and the porpoises. Academic Press, San Diego, CA. 486 p.

BOEM (Bureau of Ocean Energy Management). 2012. Atlantic OCS proposed geological and geophysical activities: Mid-Atlantic and South Atlantic Planning Areas. Draft Programmatic Environmental Impact Statement. U.S. Department of the Interior. March 2012.

Calambokidis, J., G.H. Steiger, J.M. Straley, L.M. Herman, S. Cerchio, D.R. Salden, J. Urbán R., J.K. Jacobsen, O. von Ziegesar, K.C. Balcomb, C.M. Gabrielle, M.E. Dahlheim, S. Uchida, G. Ellis, Y. Miyamura, P.L. de Guevara, M. Yamaguchi, F. Sato, S.A. Mizroch, L. Schlender, K. Rasmussen, J. Barlow, and T.J. Quinn II. 2001. Movements and population structure of humpback whales in the North Pacific. **Mar. Mamm. Sci.** 17(4):769-794.

Carwardine, M. 1995. Whales, dolphins and porpoises. Dorling Kindersley Publishing, Inc., New York, NY. 256 p.

Cattanach, K.L., J. Sigurjónsson, S.T. Buckland, and T. Gunnlaugsson. 1993. Sei whale abundance in the North Atlantic, estimated from NASS-87 and NASS-89 data. **Rep. Int. Whal. Comm.** 43:315-321.

CETAP (Cetacean and Turtle Assessment Program). 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the USA outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA51-CT8-48 to the Bureau of Land Management, Washington, DC. 538 p.

Clapham, P.J., L.S. Baraff, C.A. Carlson, M.A. Christian, D.K. Mattila, C.A. Mayo, M.A. Murphy, and S. Pittman. 1993. Seasonal occurrence and annual return of humpback whales, *Megaptera novaeangliae*, in the southern Gulf of Maine. **Can. J. Zool.** 71:440-443.

Clark, C.W. 1995. Application of U.S. Navy underwater hydrophone arrays for scientific research on whales. **Rep. Int. Whal. Comm.** 45:210-212.

Clark, C.W. and G.C. Gagnon. 2006. Considering the temporal and spatial scales of noise exposures from seismic surveys on baleen whales. Working Pap. SC/58/E9. Int. Whal. Comm., Cambridge, U.K. 9 p.

Cole T., A. Glass, P.K. Hamilton, P. Duley, M. Niemeyer, C. Christman, R.M. Pace III, and T. Fraiser. 2009. Potential mating ground for North Atlantic right whales off the Northeast USA. Abstr. 18th Bienn. Conf. Biol. Mar. Mamm., Québec City, 12–16 Oct. 2009. 58 p.

Diebold, J.B., M. Tolstoy, L. Doermann, S.L. Nooner, S.C. Webb, and T.J. Crone. 2010. R/V Marcus G. Langseth seismic source: modeling and calibration. **Geochem. Geophys. Geosyst.** 11(12), Q12012, doi:10.1029/2010GC003126. 20 p.

Dolar, M.L.L. 2009. Fraser's dolphin–*Lagenodelphis hosei*. p. 469-474 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

DoN (Department of the Navy). 2005. Marine resource assessment for the Northeast Operating Areas: Atlantic City, Narragansett Bay, and Boston. Rep. from GeoMarine Inc., Newport News, VA, for Naval Facilities Engineering Command, Atlantic; Norfolk, VA. Contract No. N62470-02-D-9997, Task Order No. 0018. 556 p.

DoN (Department of Navy). 2007. Navy OPAREA density estimates (NODE) for the Southeast OPAREAs: VACAPES, CHPT, JAX/CHASN, and Southeastern Florida and AUTEC-Andros. Rep. from GeoMarine Inc., Hampton, VA, for Department of the Navy, Naval Facilities Engineering Command, Atlantic, Norfolk, VA. Contract N62470-02-D-9997, Task Order 0060. Accessed on 24 October 2013 at http://seamap.env.duke.edu/seamap2/downloads/resources/serdp/Southeast%20NODE%20Final%20Report.pdf.

DoN (Department of the Navy). 2008a. Marine resources assessment update for the Virginia Capes Operating Area. Department of the Navy, U.S. Fleet Forces Command, Norfolk, VA. Contract #N62470-02-D-9997, CTO 0056. Prepared by GeoMarine, Inc., Hampton, Virginia. 711 p.

DoN (Department of the Navy). 2008b. Marine resources assessment update for the Cherry Point Operating Area. Department of the Navy, U.S. Fleet Forces Command, Norfolk, VA. Contract #N62470-02-D-9997, CTO 0056. Prepared by GeoMarine, Inc., Hampton, Virginia. 643 p.

DoN (Department of the Navy). 2009a. Virginia Capes Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). March 2009. NAVFAC Atlantic, Norfolk, VA. Accessed on 18 September 2013 at https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_ww_pp/navfac_hq_pp/navfac_environmental/documents/vacapes_feis_vol_1_full.pdf.

DoN (Department of the Navy). 2009b. Navy Cherry Point Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). April 2009. NAVFAC Atlantic, Norfolk, VA. Accessed on 18 September 2013 at https://portal.navfac.navy.mil/portal/page/portal/navfac/navfac_ww_pp/navfac_hq_pp/navfac_environmental/documents/navy_cherry_point_feis_vol_1a_041509.pdf.

Environment News Service. 2013. U.S. east coast dolphin die-off triggers investigation. Accessed on 17 September 2013 at http://ens-newswire.com/2013/08/08/u-s-east-coast-dolphin-die-off-triggers-investigation.

Fertl, D., T.A. Jefferson, I.B. Moreno, A.N. Zerbini, and K.D. Mullin. 2003. Distribution of the Clymene dolphin *Stenella clymene*. **Mammal Rev.** 33(3):253-271.

Gaskin, D.E. 1982. The ecology of whales and dolphins. Heineman Educational Books Ltd., London, U.K. 459 p.

Gaskin, D.E. 1984. The harbor porpoise *Phocoena phocoena* (L.): regional populations, status, and information on direct and indirect catches. **Rep. Int. Whal. Comm.** 34:569-586.

Gaskin, D.E. 1987. Updated status of the right whale, *Eubalaena glacialis*, in Canada. **Can Field-Nat** 101:295-309.

Gaskin, D.E. 1992. The status of the harbour porpoise. **Can. Field Nat.** 106(1):36-54.

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M.P. Simmonds, R. Swift, and D. Thompson. 2004. A review of the effects of seismic surveys on marine mammals. **Mar. Technol. Soc. J.** 37(4):16-34.

Hamilton, P.K. and C.A. Mayo. 1990. Population characteristics of right whales (*Eubalaena glacialis*) observed in Cape Cod and Massachusetts Bays, 1978–86. **Rep. Int. Whal. Comm. Spec. Iss.** 12:203-208.

IOC (Intergovernmental Oceanographic Commission of UNESCO). 2013. The Ocean Biogeographic Information System. Accessed on 9 September 2013 at http://www.iobis.org.

IUCN. 2013. IUCN Red list of threatened species. Version 2013.1. Accessed on 5 September 2013 at http://www.iucnredlist.org.

IWC. 2013. Whale population estimates: population table. Last updated 09/01/09. Accessed on 9 September 2013 at http://iwc.int/estimate.htm.

Jaquet, N. 1996. How spatial and temporal scales influence understanding of sperm whale distribution: a review. **Mamm. Rev.** 26:51-65.

Jefferson, T.A., M.A. Webber, and R.L. Pitman. 2008. Marine mammals of the world: a comprehensive guide to their identification. Elsevier, London, U.K. 573 p.

Jefferson, T.A., C.R. Weir, R.C. Anderson, L.T. Balance, R.D. Kenney, and J.J. Kiszka. 2013. Global distribution of Risso's dolphin *Grampus griseus*: a review and critical evaluation. **Mamm. Rev.** doi:10.1111/mam.12008.

Kasuya, T. 1986. Distribution and behavior of Baird's beaked whales off the Pacific coast of Japan. **Sci. Rep. Whales Res. Inst.** 37:61-83.

Katona, S.K., J.A. Beard, P.E. Girton, and F. Wenzel. 1988. Killer whales (*Orcinus orca*) from the Bay of Fundy to the Equator, including the Gulf of Mexico. **Rit Fiskideildar** 11:205-224.

Kenney, R.D., H.E. Winn, and M.C. Macaulay. 1995. Cetaceans in the Great South Channel, 1979–1989: right whale (*Eubalaena glacialis*). **Cont. Shelf Res.** 15:385-414.

Kenney, R.D., C.A. Mayo, and H.E. Winn. 2001. Migration and foraging strategies at varying spatial scales in western North Atlantic right whales: a review of hypotheses. **J. Cetac. Res. Manage**. **Spec. Iss.** 2:251-260.

Knowlton, A.R., J. Sigurjónsson, J.N. Ciano, and S.D. Kraus. 1992. Long-distance movements of North Atlantic right whales (*Eubalaena glacialis*). **Mar. Mamm. Sci.** 8(4):397-405.

Knowlton, A.R., J.B. Ring, and B. Russell. 2002. Right whale sightings and survey effort in the mid Atlantic region: migratory corridor, time frame, and proximity to port entrances. Final Rep. to National Marine Fisheries Ship Strike Working Group. 25 p.

Kraus, S.D., J.H. Prescott, A.R. Knowlton, and G.S. Stone. 1986. Migration and calving of right whales (*Eubalaena glacialis*) in the western North Atlantic. **Rep. Int. Whal. Comm. Spec. Iss.** 10:139-144.

Leatherwood, S., D.K. Caldwell, and H.E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. NOAA Tech. Rep. NMFS Circ. 396. U.S. Dep. Comm., Washington, DC. 176 p.

Lien J., R. Sears, G.B. Stenson, P.W. Jones, and I-Hsun Ni. 1989. Right whale, (*Eubalaena glacialis*), sightings in waters off Newfoundland and Labrador and the Gulf of St. Lawrence, 1978–1987. **Can. Field-Nat.** 103:91-93.

Lusseau, D. and L. Bejder. 2007. The long-term consequences of short-term responses to disturbance experience from whalewatching impact assessment. **Int. J. Comp. Psych.** 20(2-3):228-236.

MacLeod, C.D., W.F. Perrin, R. Pitman, J. Barlow, L.T. Ballance, A. D'Amico, T. Gerrodette, G. Joyce, K.D. Mullin, D. Palka, and G.T. Waring. 2006. Known and inferred distributions of beaked whale species (Cetacea: Ziphiidae). **J. Cetac. Res. Manage.** 7(3):271-286.

Mead, J.G. 1986. Twentieth-century records of right whales (*Eubalaena glacialis*) in the northwest Atlantic Ocean. **Rep. Int. Whal. Comm. Spec. Iss.** 10:109-120.

Mead, J.G. 1989. Beaked whales of the genus *Mesoplodon*. p. 349-430 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, San Diego, CA. 442 p.

Mitchell, E. and D.G. Chapman. 1977. Preliminary assessment of stocks of northwest Atlantic sei whales (*Balaenoptera borealis*). **Rep. Int. Whal. Comm. Spec. Iss.** 1:117-120.

Miyazaki, N. and W.F. Perrin. 1994. Rough-toothed dolphin *Steno bredanensis* (Lesson, 1828). p. 1-21 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, San Diego, CA. 416 p.

Mizroch, S.A., D.W. Rice, and J.M. Breiwick. 1984. The blue whale, *Balaenoptera musculus*. **Mar. Fish. Rev.** 46(4)15-19.

Moore, M.J., B. Rubinstein, S.A. Norman, and T. Lipscomb. 2004. A note on the most northerly record of Gervais' beaked whale from the western North Atlantic Ocean. **J. Cetac. Res. Manage.** 6(3):279-281.

Morano, J.L., A.N. Rice, J.T. Tielens, B.J. Estabrook, A. Murray, B.L. Roberts, and C.W. Clark. 2012. Acoustically detected year-round presence of right whales in an urbanized migration corridor. **Conserv. Biol.** 26(4):698-707.

Mussoline, S.E., D. Risch, L.T. Hatch, M.T. Weinrich, D.N. Wiley, M.A. Thompson, P.J. Corkeron, and S.M. Van Parijs. 2012. Seasonal and diel variation in North Atlantic right whale up-calls: implications for management and conservation in the northwestern Atlantic Ocean. **Endang. Species Res.** 17(1):17-26.

NEFSC (Northeast Fisheries Science Center). 2012. North Atlantic right whale sighting advisory system. Accessed on 11 September 2013 at http://www.nefsc.noaa.gov/psb/surveys/SAS.html.

NEFSC (Northeast Fisheries Science Center). 2013. Interactive North Atlantic right whale sightings map. Accessed on 22 August 2013 at http://www.nefsc.noaa.gov/psb/surveys.

NMFS (National Marine Fisheries Service). 1994. Designated critical habitat, northern right whale. **Fed. Regist.** (59, 3 June 1994): 28793.

NMFS (National Marine Fisheries Service). 2000. Small takes of marine mammals incidental to specified activities: marine seismic-reflection data collection in southern California/Notice of receipt of application. **Fed. Regist.** 65(60, 28 Mar.):16374-16379.

NMFS (National Marine Fisheries Service). 2001. Small takes of marine mammals incidental to specified activities: oil and gas exploration drilling activities in the Beaufort Sea/Notice of issuance of an incidental harassment authorization. **Fed. Regist.** 66(26, 7 Feb.):9291-9298.

NMFS (National Marine Fisheries Service). 2005. Recovery plan for the North Atlantic right whale (*Eubalaena glacialis*). Nat. Mar. Fish. Serv., Silver Spring, MD. 137 p.

NMFS (National Marine Fisheries Service). 2008. Endangered fish and wildlife; Final Rule to implement speed restrictions to reduce the threat of ship collisions with North Atlantic right whales. **Fed. Regist.** 73(198, 10 Oct.):60173-60191.

NMFS (National Marine Fisheries Service). 2010. Endangered fish and wildlife and designated Critical Habitat for the endangered North Atlantic right whale. **Fed. Regist.** 75:(193, 6 Oct.):61690-61691.

NMFS (National Marine Fisheries Service). 2013a. Takes of marine mammals incidental to specified activities; marine geophysical survey on the Mid-Atlantic Ridge in the Atlantic Ocean, April 2013, through June 2013. Notice; issuance of an incidental harassment authorization. **Fed. Regist.** 78 (72, 15 Apr.):22239-22251.

NMFS (National Marine Fisheries Service). 2013b. Takes of marine mammals incidental to specified activities; marine geophysical survey in the northeast Atlantic Ocean, June to July 2013. Notice; issuance of an incidental harassment authorization. **Fed. Regist.** 78 (109, 6 Jun.):34069-34083.

NMFS (National Marine Fisheries Service). 2013c. Effects of oil and gas activities in the Arctic Ocean: Supplemental draft environmental impact statement. U.S. Depart. Commerce, NOAA, NMFS, Office of Protected Resources. Accessed at http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm on 21 September 2013.

NOAA (National Oceanic and Atmospheric Administration). 2006. NOAA recommends new east coast ship traffic routes to reduce collisions with endangered whales. Press Release. Nat. Ocean. Atmos. Admin., Silver Spring, MD, 17 November.

NOAA (National Oceanic and Atmospheric Administration). 2007. NOAA & coast guard help shift Boston ship traffic lane to reduce risk of collisions with whales. Press Release. Nat. Ocean. Atmos. Admin., Silver Spring, MD, 28 June.

NOAA (National Oceanic and Atmospheric Administration). 2013a. Draft guidance for assessing the effects of anthropogenic sound on marine mammals: acoustic threshold levels for onset of permanent and temporary threshold shifts. Draft: 23 December 2013. 76 p.

NOAA (National Oceanic and Atmospheric Administration). 2013b. 2013 bottlenose dolphin unusual mortality event in the mid-Atlantic. Accessed on 28 November 2013 at http://www.nmfs.noaa.gov/pr/health/mmume/midatldolphins2013.html.

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. **Mamm. Rev.** 37(2):81-115.

NRC (National Research Council). 2005. Marine mammal populations and ocean noise/Determining when noise causes biologically significant effects. U.S. Nat. Res. Counc., Ocean Studies Board, Committee on characterizing biologically significant marine mammal behavior (Wartzok, D.W., J. Altmann, W. Au, K. Ralls, A. Starfield, and P.L. Tyack). Nat. Acad. Press, Washington, DC. 126 p.

NSF (National Science Foundation). 2012. Record of Decision for marine seismic research funded by the National Science Foundation. June 2012. 41 p. Accessed at http://www.nsf.gov/geo/oce/envcomp/rod-marine-seismic-research-june2012.pdf on 23 September 2013.

NSF and USGS (National Science Foundation and U.S. Geological Survey). 2011. Final Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey. Accessed on 23 September 2013 at http://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis-with-appendices.pdf.

Odell, D.K. and K.M. McClune. 1999. False killer whale *Pseudorca crassidens* (Owen, 1846). p. 213-243 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 6: The second book of dolphins and the porpoises. Academic Press, San Diego, CA. 486 p.

Olson, P.A. 2009. Pilot whales. p. 847-852 *In*: W.F. Perrin, B. Würsig and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

Palka, D.L. 2006. Summer abundance estimates of cetaceans in U.S. North Atlantic Navy Operating Areas. Northeast Fish. Sci. Center Ref. Doc. 06-03. Northeast Fish. Sci. Center, Nat. Mar. Fish. Serv., Woods Hole, MA. 41 p.

Palka, D. 2012. Cetacean abundance estimates in U.S. northwestern Atlantic Ocean waters from summer 2011 line transect survey. Northeast Fish. Sci. Cent. Ref. Doc. 12-29. Northeast Fish. Sci. Center, Nat. Mar. Fish. Serv., Woods Hole, MA. 37 p.

Palsbøll, P.J., J. Allen, T.H. Anderson, M. Berube, P.J. Clapham, T.P. Feddersen, N.A. Friday, P.S. Hammond, H. Jorgensen, S.K. Katona, F. Larsen, J. Lien, D.K. Mattila, F.B. Nygaard, J. Robbins, R. Sponer, R. Sears, J. Sigurjonsson, T.G. Smith, P.T. Stevick, G.A. Vikingsson, and N. Oien. 2001. Stock structure and composition of the North Atlantic humpback whale, *Megaptera novaeangliae*. Working Pap. SC/53/NAH11. Int. Whal. Comm., Cambridge, U.K.

Patrician, M.R., I.S. Biedron, H.C. Esch, F.W. Wenzel, L.A. Cooper, P.K. Hamilton, A.H. Glass, and M.F. Baumgartner. 2009. Evidence of a North Atlantic right whale calf (*Eubalaena glacialis*) born in northeastern U.S. waters. **Mar. Mamm. Sci.** 25(2):462-477.

Payne, R. S. and S. McVay. 1971. Songs of humpback whales. **Science** 173(3997):585-597.

Perrin, W.F., D.K. Caldwell, and M.C. Caldwell. 1994a. Atlantic spotted dolphin *Stenella frontalis* (G. Cuvier, 1829). p. 173-190 *In*: S.H. Ridgway and R.J. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, San Diego, CA. 416 p.

Perrin, W.F., S. Leatherwood, and A. Collet. 1994b. Fraser's dolphin *Lagenodelphis hosei* Fraser, 1956. p. 225-240 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London, U.K. 416 p.

Perryman, W.L., D.W.K. Au, S. Leatherwood, and T.A. Jefferson. 1994. Melon-headed whale *Peponocephala electra* Gray, 1846. p. 363-386 *In*: S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London, U.K. 416 p.

Pierson, M.O., J.P. Wagner, V. Langford, P. Birnie, and M.L. Tasker. 1998. Protection from, and mitigation of, the potential effects of seismic exploration on marine mammals. Chapter 7 *In*: M.L. Tasker and C. Weir (eds.), Proc. Seismic Mar. Mamm. Worksh., London, U.K., 23–25 June 1998.

Pike, D.G., G.A. Víkingsson, T. Gunnlaugsson, and N. Øien. 2009. A note on the distribution and abundance of blue whales (*Balaenoptera musculus*) in the central and northeast North Atlantic. **NAMMCO Sci. Publ.** 7:19-29.

Read, A.J., P.N. Halpin, L.B. Crowder, B.D. Best, and E. Fujioka (eds.). 2009. OBIS-SEAMAP: Mapping marine mammals, birds and turtles. World Wide Web electronic publication. Accessed on 20 August 2013 at http://seamap.env.duke.edu/prod/serdp/serdp_map.php.

Reeves, R.R. 2001. Overview of catch history, historic abundance and distribution of right whales in the western North Atlantic and in Cintra Bay, West Africa**. J. Cetac. Res. Manage. Spec. Iss.** 2:187-192.

Reeves, R.R. and E. Mitchell. 1986. American pelagic whaling for right whales in the North Atlantic. **Rep. Int. Whal. Comm**. **Spec. Iss.** 10:221-254.

Reeves, R.R., C. Smeenk, R.L. Brownell, Jr., and C.C. Kinze. 1999. Atlantic white-sided dolphin *Lagenorhynchus acutus* (Gray, 1828). p. 31-58 *In*: S.H. Ridgeway and R. Harrison (eds.), Handbook of marine mammals, Vol. 6: The second handbook of dolphins and the porpoises. Academic Press, San Diego, CA. 486 p.

Rice, D.W. 1998. Marine mammals of the world, systematics and distribution. Spec. Publ. 4. Soc. Mar. Mammal., Allen Press, Lawrence, KS. 231 p.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press, San Diego. 576 p.

Sears, R. and W.F Perrin. 2000. Blue whale. p. 120-124 *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.), Encyclopedia of marine mammals, 2nd edit. Academic Press, San Diego, CA. 1316 p.

Selzer, L.A. and P.M. Payne. 1988. The distribution of white-sided (*Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. **Mar. Mamm. Sci.** 4:141-153.

Simard, Y., F. Samaran, and N. Roy. 2005. Measurement of whale and seismic sounds in the Scotian Gully and adjacent canyons in July 2003. p. 97-115 *In*: K. Lee, H. Bain, and C.V. Hurley (eds.), Acoustic monitoring and marine mammal surveys in The Gully and outer Scotian Shelf before and during active seismic surveys. Environ. Stud. Res. Funds Rep. 151. 154 p. (Published 2007).

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. **Aquat. Mamm.** 33(4):411-522.

Tolstoy, M., J. Diebold, L. Doermann, S. Nooner, S.C. Webb, D.R. Bohenstiehl, T.J. Crone, and R.C. Holmes. 2009. Broadband calibration of R/V *Marcus G. Langseth* four-string seismic sources. **Geochem. Geophys. Geosyst.** 10, Q08011, doi:10.1029/2009GC002451. 15 p.

UNEP-WCMC (United Nations Environment Programme-World Conservation Monitoring Centre). 2012. Convention on International Trade in Endangered Species of Wild Flora and Fauna. Appendices I, II, and III. Valid from 12 June 2013. Accessed in August 2013 at http://www.cites.org/eng/app/2013/E-Appendices-2013-06-12.pdf.

USCG (U.S. Coast Guard). 1999. Mandatory ship reporting systems. **Fed. Regist.** 64(104, 1 June):29229-29235.

USCG (U.S. Coast Guard). 2001. Mandatory ship reporting systems–Final rule. **Fed. Regist.** 66(224, 20 Nov.):58066-58070.

Vigness-Raposa, K.J., R.D. Kenney, M.L. Gonzalez, and P.V. August. 2010. Spatial patterns of humpback whale (*Megaptera novaeangliae*) sightings and survey effort: insight into North Atlantic population structure. **Mar. Mamm. Sci.** 26(1):161-175.

Ward-Geiger, L.I., G.K. Silber, R.D. Baumstark, and T.L. Pulfer. 2005. Characterization of ship traffic in right whale Critical Habitat. **Coast. Manage.** 33:263-278.

Waring, G.T., C.P. Fairfield, C.M. Ruhsam, and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the Northeastern U.S.A. shelf. **ICES C.M.** 1992/N:12.

Waring, G.T., T. Hamazaki, D. Sheehan, G. Wood, and S. Baker. 2001. Characterization of beaked whale (Ziphiidae) and sperm whale (*Physeter macrocephalus*) summer habitat in shelf-edge and deeper waters off the northeast U.S. **Mar. Mamm. Sci.** 17(4):703-717.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.) 2010. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments–2010. NOAA Tech. Memo. NMFS-NE-219. 591 p.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E Rozel (eds.). 2013. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments–2012. Vol. 1. 419 p. Accessed on 27 August 2013 at http://www.nmfs.noaa.gov/pr/sars/pdf/ao2012.pdf. Vol. 2. 79 p. Accessed on 27 August 2013 at http://www.nmfs.noaa.gov/pr/sars/pdf/ao2012_10stocks.pdf.

Wartzok, D., A.N. Popper, J. Gordon, and J. Merrill. 2004. Factors affecting the responses of marine mammals to acoustic disturbance. **Mar. Technol. Soc. J.** 37(4):6-15.

Weilgart, L.S. 2007. A brief review of known effects of noise on marine mammals. **Int. J. Comp. Psychol.** 20:159-168.

Weinrich, M.T., R.D. Kenney, and P.K. Hamilton. 2000. Right whales (*Eubalaena glacialis*) on Jeffreys Ledge: a habitat of unrecognized importance? **Mar. Mamm. Sci.** 16:326-337.

Weir, C.R. and S.J. Dolman. 2007. Comparative review of the regional marine mammal mitigation guidelines implemented during industrial seismic surveys, and guidance towards a worldwide standard. **J. Int. Wildl. Law Policy** 10(1):1-27.

Wenzel, F., D.K. Mattila, and P.J. Clapham. 1988. *Balaenoptera musculus* in the Gulf of Maine. **Mar. Mamm. Sci.** 4(2):172-175.

Westgate, A.J., A.J. Read, T.M. Cox, T.D. Schofield, B.R. Whitaker, and K.E. Anderson. 1998. Monitoring a rehabilitated harbor porpoise using satellite telemetry. **Mar. Mamm. Sci.** 14(3):599-604.

Whitehead, H. 2002. Estimates of the current global population size and historical trajectory for sperm whales. **Mar. Ecol. Prog. Ser.** 242:295-304.

Whitt, A.D., K. Dudzinski, and J.R. Laliberté. 2013. North Atlantic right whale distribution and seasonal occurrence in nearshore waters off New Jersey, U.S.A., and implications for management. **Endang. Species Res.** 20:59-69.

Winn, H.E., C.A. Price, and P.W. Sorensen. 1986. The distributional biology of the right whale (*Eubalaena glacialis*) in the western North Atlantic. **Rep. Int. Whal. Comm. Spec. Iss.** 10:129-138.

Würsig, B., T.A. Jefferson, and D.J. Schmidly. 2000. The marine mammals of the Gulf of Mexico. Texas A&M University Press, College Station, TX. 232 p.